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A QUARTERLY MISCELLANY OF
ENTERTAINING AND INSTRUCTIVE ARTICLES ON
SCIENTIFIC SUBJECTS.

EDITED BY HENRY LAWSON, M.D.

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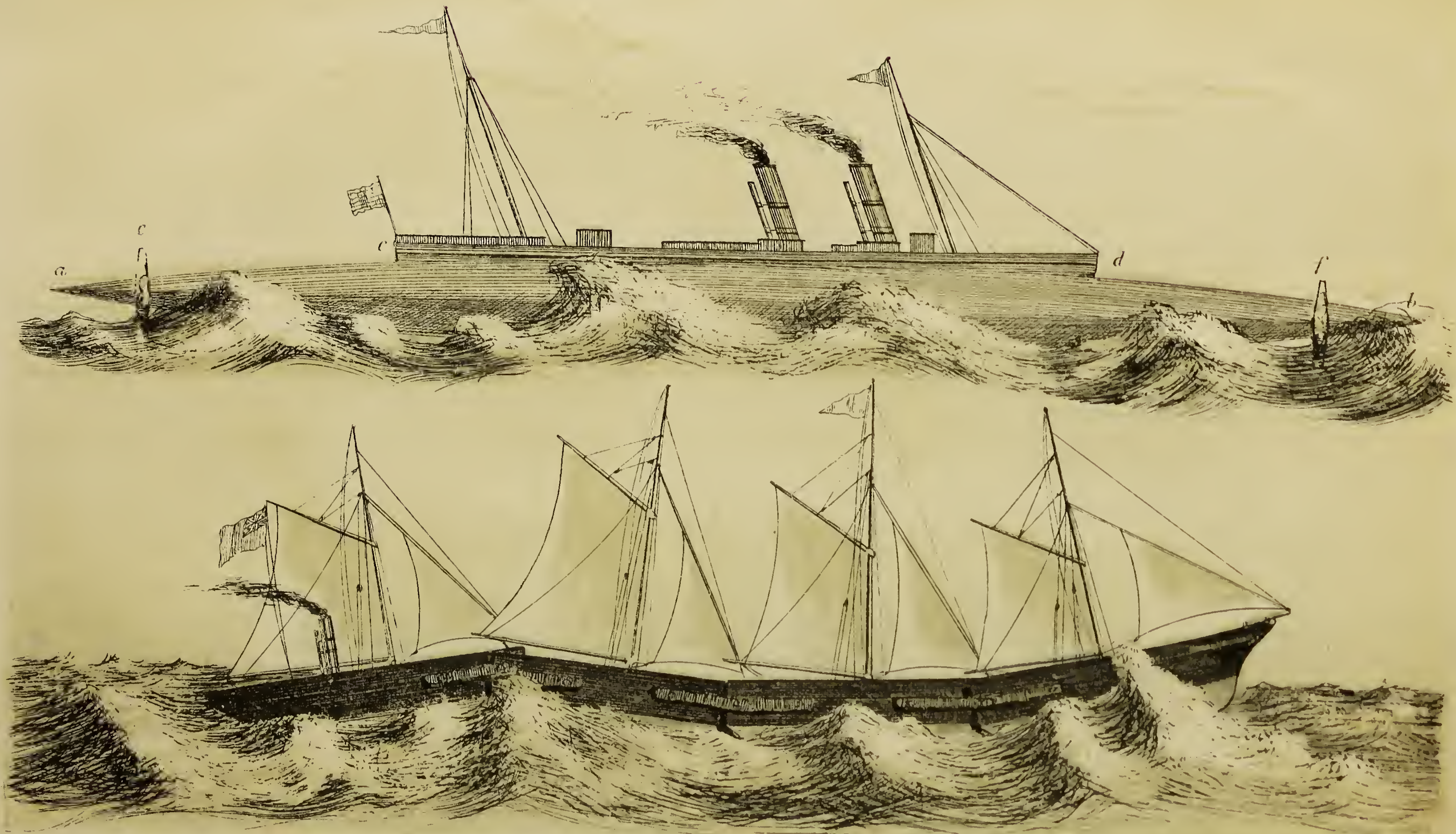
BRITISH MUSEUM
NATURAL HISTORY

Plate 1



Mackie lith.

THE

POPULAR SCIENCE REVIEW.

EXTRAORDINARY SHIPS.

BY S. J. MACKIE.

THERE is a considerable difference between a Dutch galliot and a British "three-decker," but scarcely greater to the eye than will be the difference between an ordinary steam-ship of the present day and those of futurity if "Winan's yacht" should prove a success. But the "cigar-ship" now building in Mr. Hepworth's yard, on the Thames, is not the only strange ship projected or afloat; and a few words on a few "extraordinary ships" will not at this season be out of place. Up to the running of the *Comet* on the Clyde in 1812, the ships of every age had been essentially *sailing*-vessels. Oars worked by human hands were the only aids employed. But the introduction of steam marked altogether a new era in ship-building. With the introduction of a self-carrying power of propulsion *through the water*, points of construction previously of minor moment in sailing-ships, became matters of fundamental importance in steamers. In short, the primary and chief obstacle to progression was the *resistance* of the water to the *moving object.* This was formerly estimated as increasing as the square of the velocity, while the cubes of the squares were taken as the requisite driving steam-power. The midship section of the old bluff-bowed vessels was taken as practically a square area to be driven by main steam-force through the water. It is evident the limit of steam-power would soon be thus attained. And so it was. Another mile an hour was got by putting on more steam-power; and then more steam, and another mile or two; and then—the engines broke down. But the direct resistance which a plane surface has to overcome is not experienced by triangular or wedge-shaped bodies; hence the idea of adding more or less triangular or wedge-shaped ends to the square middle portion of the ship.

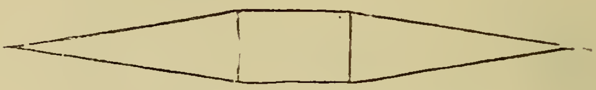


Fig. 1.—Rudimentary Plan of Ship.

Such, then, was the rudimentary idea of the modern steamship—wedge-shaped bows to cleave the water; wedge-shaped stern to allow the recoil waters free run to the rudder for good steering. Various modifications were from time to time introduced, and retained or abandoned, according to their observable success or failure, or their suitability to particular purposes. Fig. 2 shows the simplest and earliest form of midship section, which is most nearly that of a square. Fig. 3 is an ordinary midship section of a modern carrying vessel. Both presenting considerable superficial area if driven bluffly through the sea. With the improvements in steamers improvements were attempted in sailing-vessels, and many fanciful notions of hulls were tried and experimented on. The most important of these were the cylindrical and the wedge-shaped. The value of the last was singularly at variance with the preconceived ideas of making a sailing-ship carrying a great press of sail deep in the water and heavily ballasted, by proving that the main resistance to the capsizing leverage of the masts was in the *breadth* of the upper part or deck—in "beam." But *the most* remarkable sailing-vessel was the yacht *America*, in form something like this (fig. 4). About 100 feet in length; her bow was nearly two-thirds, or considerably more than 50 feet.

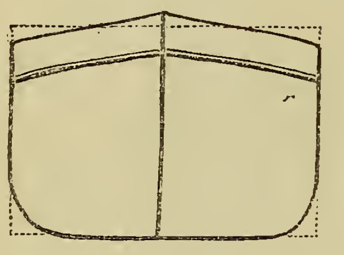


Fig. 2.—Primary Square Midship Section.

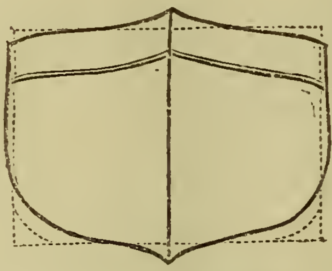


Fig. 3.—Ordinary Midship Section.

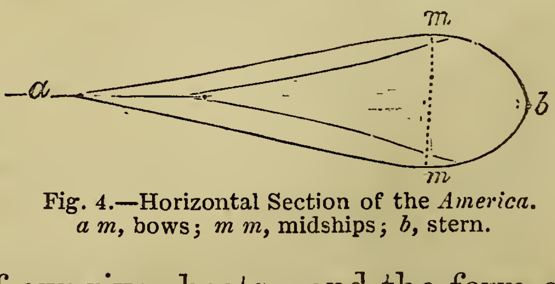


Fig. 4.—Horizontal Section of the *America*. *a m*, bows; *m m*, midships; *b*, stern.

To return, however, to steamers. When the water is driven aside by a moving object it forms a wave, as we daily see along the bows of our river boats; and the form of this wave will vary with the sharpness or bluntness of the object causing it, as also with the rate at which it is moving. Now, if the form of the vessel be made coincident with that of the wave thrown up by her passage, it is evident that the greatest amount of bulk of hull, and the longest distance of progress, will be obtained compatible with the least amount of friction and resistance in the water through which it moves. This was Mr. Scott Russell's idea, and from his elaborate and costly experiments have resulted those beautiful, we might well call them exquisite, lines upon which the fleetest steamers in the world have been modelled. Let us see what the "wave line" means. Steam power being equal, if the *long* bow could be pushed for its *entire length* through the water in the *same time* that it took to force the *short* bluff bow through for its *length*, the *greatest amount of work would be done with the least possible amount of resistance.* Now, what happens when a vessel goes through the water? Her stem strikes against the particles of water and drives them off by the impetus of her motion at a right angle. By the old round-bowed vessels the particles of water were smashed off to the distance of the extreme width of the vessel in the *shortest* possible time. In the long, sharp-bowed vessel they are pushed aside proportionally in the *longest* possible time as the bows are more and more acute.

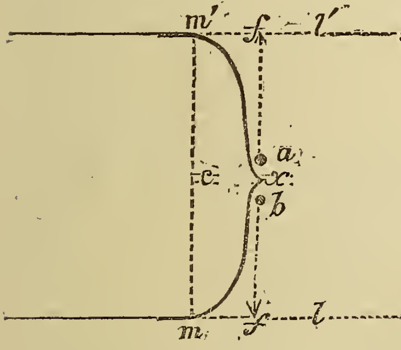


Fig. 5.—Action of Bluff Bow on Water.

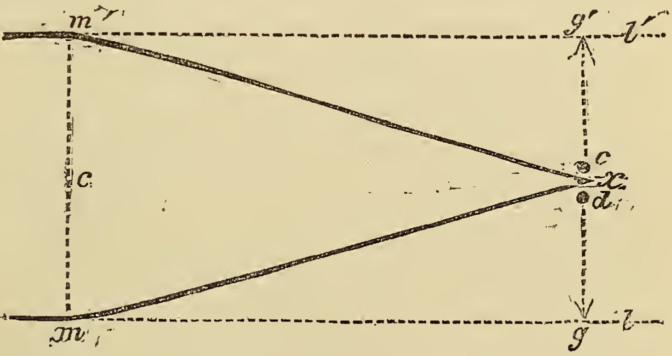


Fig. 6.—Action of Sharp Bow on Water.

Let the dots *a b* be the particles of water first struck by the stem of an old bluff bow; they would respectively have to travel laterally from *x* up to the lines of extreme width of the ship, *m f*, *m′ f′*, while the head of the midship portion *m* progressed from *m* to *f*; while, with a vessel with the sharp bow (fig. 6), moving at the *same rate*, the like particles first struck, *c d*, would only have been pushed to *g* in the time the ship was progressing from *m* to *g*. In other words, the steam-power being the same, the bluff vessel (fig. 7) would have been forced through the *length* of her bow, *c x*, in the *same time* that the sharp-bowed vessel (fig. 8) had been pushed through the water the *length* of her bow, *c x* (fig. 9). The gain, therefore, in progression from *form only* to the sharp vessel would have been the difference of the length of her bow over that of her antagonist.

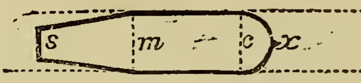


Fig. 7.

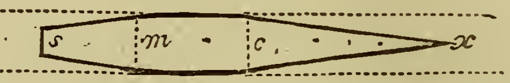


Fig. 8.

Having ascertained the exact curve of the wave of water resistance to a given rate of motion, Mr. Scott Russell reversed this for the bow line of his ship; and while driving the vessel thus constructed at the rate of seventeen miles an hour, he placed two oranges in front of her. When her bow passed between them the oranges rolled close alongside the whole way to the midships; thus showing that the *true* "wave-line" for this rate of speed had been attained, and that no greater force had been applied than was necessary to move them out of the way of the vessel. Against a non-coincident curved bow, or a straight one, the oranges would have struck and re-struck many times before reaching the widest part amidships.

Now, if with the same rate of speed the same line of form could be maintained in all weathers, nothing could surpass the properties of wave-line vessels. But with every roll and lurch in ordinary as well as in wave-line steamers, the *actual* lines of form *passed through the water* deviate from the *true wave-lines* in proportion to the amounts of lateral and longitudinal movements of the vessel, and frictional resistance proportionate to these deviations is set up. When we state that the resistance to a square foot of plane surface, moved at six feet depth at eight knots an hour, has been proved by experiment to be 196·245 lb., and that moved at higher velocities, the resistance would be as the square of the increased velocity, the immense value of the *form* of a ship in respect to the attainment of speed will be appreciated.

In regularity and equalness of lines actually passed through the water, under all the varying obstructions to which navigable vessels are subjected, the "cigar ship" will undoubtedly be superior to every other; and for equality of length of voyages will, as undoubtedly, be remarkable. But whether fusiform or spindle-shaped ships will be able with the *same* amount of steam-power to obtain the same amount of speed as the wave-line boats in smooth water, may be doubted.

But let us see what the "cigar-ship" is like. We give her portrait in Plate I.

Her length is 256 feet; breadth and depth, of course alike, 16 feet; her deep displacement—for she will be from two-thirds to three-fifths immersed—will be 500 tons. Her longitudinal curves are arcs of a circle of 1,028 feet radius; the length of hull to beam being 16 to 1, or about double the proportion of an ordinary ship. About one-fourth of its length projects at each end beyond the raised deck and bulwarks; the object of this arrangement being to avoid the shipping of seas in rough weather. The skin-plates are of excellent iron in the lower part, and in the upper, or arching over, of toughened steel, strengthened for 130 feet in her middle portion by four longitudinal ribs.

She is divided by bulkheads and an internal longitudinal deck into eight water-tight compartments. Her propelling apparatus, it is stated, will consist of two screws, 22 feet in diameter, with which the conical ends (Plate *e a f b*) of the ship itself will revolve. We confess ourselves surprised at the enormous diameter of these screw-propellers; for, exceeding the widest diameter of the hull, Mr. Winan's yacht can never be allowed to take the ground in a tidal harbour, but must always be kept afloat. The great sweep of screw will give high speed if it can be worked at anything like a competent number of revolutions; but taking the largest screw of the *Great Eastern,* which is but 2 feet more in diameter, for comparison, we may well doubt if two screws of such nearly approximate size as 22 to 24 feet can be effectively worked by so much smaller a vessel. The *Great Eastern* is a "big ship" designed to develop the capacities of mere bulk and the double application of paddle-and-screw propellers. Of "big ships" we had in 1838 the *Great Western,* 1,340 tons; in 1845 the *Great Britain,* 3,200 tons; in 1855 the *Persia,* 3,300 tons; in 1858 the *Duke of Wellington* (man-of-war) 3,759 tons; and in 1859 the huge *Great Eastern,* the biggest ship ever floated, exceeding even Noah's ark. We leave the *Warrior* and the iron-clads out of the purely big ship class. The accompanying sketches give the relative sizes of those large ships. The exact dimensions of the *Great Eastern* are 692 feet length; 83 feet beam; 58 feet depth; 22,500 tons bulk; 28 feet draught of water. Compare this with the dimensions of Winan's yacht, given above, and it is certain that with steam-power worked at the same pressure, the smaller vessel could not make as many revolutions of her two half-immersed screws as the "leviathan" ship. It is not

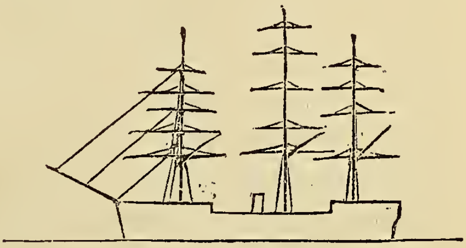


Fig. 9.—The Duke of Wellington.

surprising, then, that every means have been employed to get high steam-power in the "cigar-ship;" and that instead of her engines working like the *Great Eastern* at 25 lb. pressure, they will be worked at 150 lb., or even 180 lb. to the square inch. An important improvement, too, has been made in the arrangement of the tubes of the vertical boilers with which she is furnished, in respect to the central portion being left open for the down current of the water during the ebullition, while the upper part is freely open for the superheating of the steam. This open central space permits also the cleansing off of the saline deposits from the evaporated water which encrust the tubes, an operation impossible in ordinary tubular boilers, which consequently suffer greatly from corrosion.

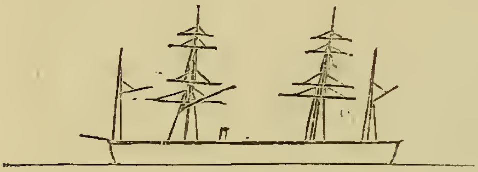


Fig. 10.—The Great Britain.

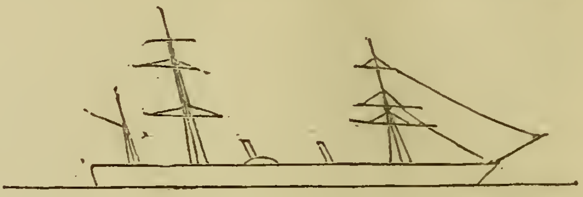


Fig. 11.—The Persia.

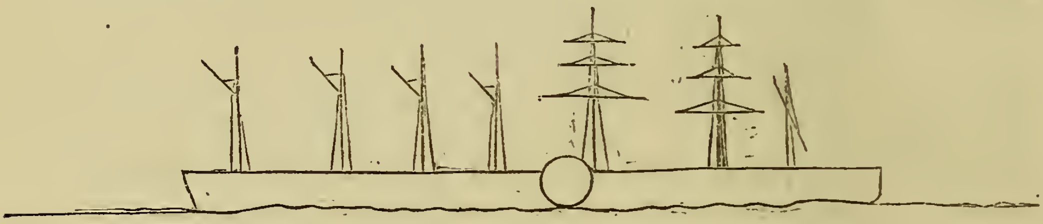


Fig. 12.—The Great Eastern.

There may be some slight gain of cubical dimensions by the "cigar-ship" from the difference in the form of her hull over that of an ordinary vessel, as we may see by superposing the diagram of the vertical midship section of the one over the other, as in fig. 13, in which both sections have the same length of boundary, and would, therefore, require the same amount of material to inclose them. But there is no such difference as should give space for any remarkably disproportionate quantity of steam-power. Working the engines at a higher pressure is simply putting more steam-power in the same amount of space; and if there were no difference of limits put by mere size on the pressure the boilers of the biggest ship would bear, there is no other reason

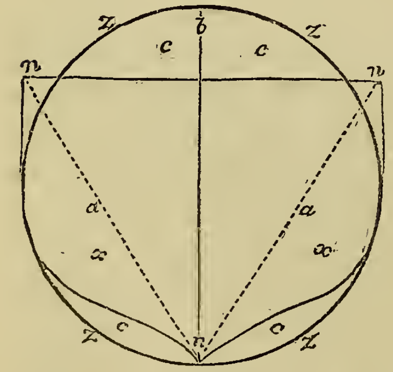


Fig. 13.—Superposed Midship Sections of "Cigar-ship" and Ordinary Ship.

why they should not be worked at the same number of atmospheres as those of the smaller vessel.

There are other comparisons well worth making as to the differences between the "cigar-ship" and ordinary shaped vessels. In the first place, make a vertical section of the "cigar-ship" wherever we may, it presents a perfect circle (*c c c c*); while in corresponding sections of an ordinary vessel the sections are all more and more V-shaped as they approach the extremities, until at last we reach the vertical stem, or the stern-post. It is quite evident thus that towards either end of an ordinary ship there are considerable portions which have not sufficient cubical displacement to be self-supporting, and which must consequently be buoyed up at the expense of the middle portion of the hull. On the other hand, although the sections of the "cigar-ship" present in either direction a series of diminishing circles; yet every part of the ship, being actually a frustrum of a cone, has cubical capacity enough to be self-buoyant in the water, and is not indebted to any other portion for support, and this even to the narrow-pointed end-cones beyond the screws. The primary effects of this universal buoyancy should be less pitching and 'scending in rough weather, and a gain of cargo, coal, or engine weight, equivalent to the dead weight of those unbuoyant parts which an ordinary vessel always has, and which the "cigar-ship" has not.

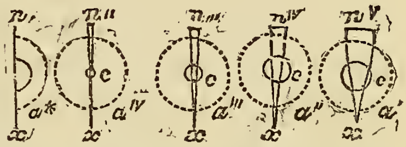


Fig. 14.—Superposed Sections of Extremities of Ordinary and of "Cigar-ship."*

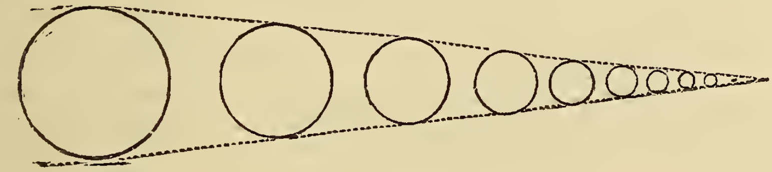


Fig. 15.—Diminishing Circular Section of "Cigar ship."

Now if a vessel be properly weighted by her engines and cargo in the centre the dead weights at both ends will, although acting on a leverage, oscillate freely, like two even-weighted boys at the ends of a well-balanced plank in ordinary "seesaw," and she will be an "easy-going" ship. But if one boy be heavier than the other, and the plank be not properly balanced to meet the difference of weight by corresponding difference of leverage, the see-saw will not be a pleasant game. So with an ordinary vessel, there are oscillating dead weights at each end, and if the weights of engine and cargo are not placed "trim," so as by their inertia to bring the fulcrum which the sea gives to the vessel in her longitudinal movements in the proper place, she will be an "uneasy" vessel. As there is always a difference of weight and displacement between the bows and stern of an ordinary ship, the dead weight of engines and cargo must be so placed as to bring the fulcrum of water under the vessel at that point upon each side of which the weight of the bows and the stern, by reason of increased or diminished leverage, are equally balanced,—not an easy thing to do. It is evident, on the other hand, that the hollow spindle, having its greatest cubic capacity directly in the centre, will have *there* the greatest weight of engine and cargo; that also every part being buoyant, there will be no dead weights oscillating at either equal or unequal leverages; and that there would be but little pitching and 'scending even if the vessel were bodily lifted by a large high wave, for the greatest weight of the ship being in the centre of her length (at *m*) would possess a massiveness there incompatible with any lengthened oscillations of her light and buoyant extremities (*a*, *d*). It is likely the "cigar-ship," from her length and the fineness of her lines, may strike right through a sea; but if she does her deck is raised over the highest point of the central and biggest portion of the spindle, and well protected with bulwarks.

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* The dotted circles *a'* to *a** represent the equivalent quantity of material to that contained in the ordinary ship's sections.

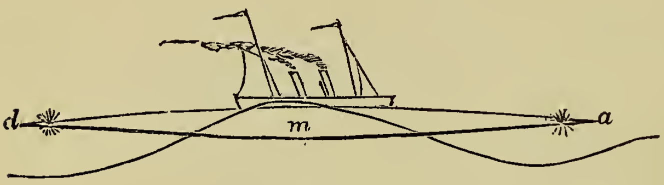


Fig. 16.—"Cigar-ship" on a tall Wave.

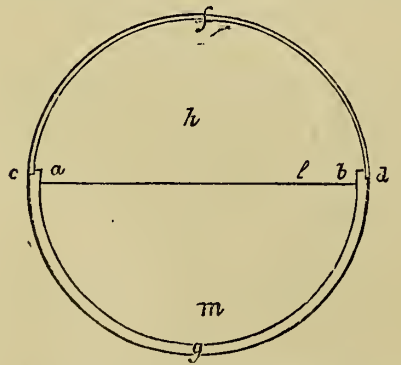


Fig. 17.—Section of Hull, showing Thickness of Plates of Skin above and below the Water-line.

That which strikes one as most likely to happen, and most awkward if it did, is that the spindle-form hull seems uncommonly likely to roll round; and, indeed, the raised deck and smoke funnels look as if in lurching they would pull her over and form an unintentional keel to keep her wrong side up. A very little mechanical knowledge will soon, however, satisfy one that such an accident cannot well occur. In the first place, the under-plates of the hull are $\frac{5}{8}$ inch thick, and strengthened by an outer plate 1 inch in thickness; while the upper skin-plates are $\frac{5}{16}$ only, or half the thickness, and without any outer plate; consequently, the lower or submerged half of the hull is naturally heavier than the upper. In addition to which, we know that a loaded bowling-ball will not roll, but will oscillate backwards and forwards until it comes to rest. The engines and cargo of the "cigar-ship" practically load her, and no probable amount of lateral motion from the sea is at all likely to turn her over.

The primary consideration of the applicability of a screw-propeller to the work it has to do is its "pitch;" that is the length in which the screw-whorl makes a complete turn round its central axis: and this "pitch" is either "finer" or "coarser," as the length of the axis (*a b*) is shorter or longer; or, in other words, as the turns of the screw are closer together or further apart.

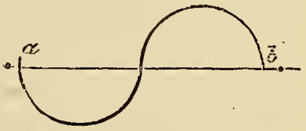


Fig. 18.—Pitch of Screw.

It is evident that if there be no "slip"—that is, if the screw retains full hold upon the water, as a carpenter's screw does upon a board—that in every revolution of the screw-propeller a distance of the length of the axis of the full turn of the screw will have been accomplished by the vessel. If thus the "pitch" of the screw be 40 feet—that is, if from *a* to *b* be 40 feet—then every full revolution of the screw will—if there be no "slip"—advance the vessel 40 feet through the water.

But the dense resistance of the water to the passage of the vessel forces the flat surface of the screw-propeller against the water in which it revolves, and the water, being displaceable, gives way proportionately to the pressure upon it; and consequently, there is a certain amount of what is expressively and correctly termed "slip," in many cases amounting to as much as thirty-five per cent. Two considerations are thus involved: whether there is less loss by "slip" in a screw of coarse pitch working at a slower rate, or in one of fine pitch working with quicker revolutions. The effects of fine and coarse pitches are being practically tried by Mr. Winan, and until the experiments are completed, it would be premature to speculate upon what the half-immersed propellers of the "cigar-ship" are likely to accomplish.

We now turn to another class of vessels altogether,—one that has much more of a commercial than of a scientific character—"Connector-ships." The present model vessel which one often sees on the Thames, and occasionally at some of our seaports, may be most fitly termed a sea-train. She consists of an after or engine compartment, and a fore or bow compartment. Between these two ends a greater or less number of ordinary carrying compartments—convex in front, concave behind—are linked together, and being secured by pivot-hinges at the side, are driven through the water as one ship by the engine compartment behind them: the front compartment serving for cabin accommodation for the crew. The idea involved in her construction is that, as high speed is not an object, small steam-power will suffice to drive such a train of compartments through the water from one port to another, and *be kept constantly* employed—compartments being always at each port loading and unloading, while full ones are being worked on their voyages. Calculations have been made to show that this plan might be very economical. With profits and losses or gains of merchants, however, we have nothing to do here. We have to deal with principles, and their practical application. The idea of a connector-ship or water-train is not in itself fundamentally novel. There was a steam train on the Indus in 1859, in which year the Oriental Inland Steam Navigation Company attempted to carry out Mr. Bourne's patented plan of a train of barges, but totally failed.

The idea was that a number of connected barges could be towed with the bow-resistance of one *steamer* only. The result of the trial in the harbour of Kurrachee was very singular. The speed of the steamer alone was 9·37 statute miles per hour, with 273 indicated horse power. With a 40-feet barge the speed was reduced to 7·19; with 303 horse power, with a second barge, to 5·75; with 332 horse power, with three barges, to 4·33 miles per hour—a speed hopeless for the navigation of the river.

The first effort, however, to effect a water-train was long anterior to this, and was made by Sir Samuel Bentham in 1781. This vessel-train was constructed at the Prince Potemkin's works in Russia, and conveyed the Empress Catherine II. down the Dnieper.

There is, however, as great a difference in principle between the horizontal flexibility and requirements of an Indian river-train, and the vertical flexibility and requirements of a sea-train, as there is between up-and-down and sideways. The principal engineering objection against such a sea train is the presumed possibility of the dislocation of the compartments in rough weather by twist; but the practical voyages actually performed by the model *Connector* seems to satisfactorily solve this question in favour of the ship. In calms, with the connector-ships all may be presumed to go on smoothly enough. The engine, being behind, gives this advantage over the Indus train, that it pushes its load before it through the smooth *undisturbed* sea, while the latter lugged its load after it through the troubled waters of its own making—a very essential difference. Steam power, then, being adequate to the work before it, these sea-trains will be perfectly manageable in fine weather. Now for a storm. Bow on the front compartment receives the wave, and being empty of cargo, rises buoyantly to it; compartment after compartment is passed by the rushing waters, and each yields more or less to the uplift, according to the weight that is in it. Well, the compartments are all so hinged together, that the requisite amount of vertical flexibility is freely given. There may be some loss of engine-power in extreme cases of the various pitchings and 'scendings of the various compartments; but, the connections being lateral, and at the upper part of the vessel, act freely as hinges to the compartments, on the risings and depressions of the waves. So much for vertical motion.

There *seems* more reason to dread the lateral force of the waves, and accordingly we find *this* has been the point most strongly urged against the connector-ship, and the one that has acted most to the prejudice, so far, of her commercial application. Now what is the wave which comes against the side of a vessel at sea? A rushing body of water? No; it is not like a "breaker" on the shore; it is a rolling force of *motion* passing on in an undulating course *through* a body of water. In sea waves there is a translation of force, but no actual rush of water. Wave after wave lifts whatever floats upon it, but there is no progression of the floating object. If, then, the *Connector* were broadside on to the waves, they would simply lift her. But here the important question comes, whether they would lift every compartment equitably together, or whether from the inequalities in the height of the waves in the strike of their crests, there would not occur such an amount of irregular motion amongst the various compartments as to cause sufficient twist between one and the other to damage or break off the connections. For our own part, we certainly think sufficient play and strength can be given to the connecting joints as to permit of such trains being put to sea and managed in all weathers, except, perhaps, the most violent storms. Even if disconnection did take place, it would not follow that further disaster must be the sequence.

There is yet another extraordinary ship that ought to be noticed, though none of us have seen her, and though what *good* she is to do passes comprehension. That is one destined to go down to the bottom of the sea. The first experimental vessel did go there and stuck fast in the mud. Perhaps some of our readers may think that so many ships go there unintentionally that it is a superlative invention to design one to go there especially. But so it is. There has been designed a submarine ship. She was not intended to dive for freights of pearls or oysters, nor to fish up treasures from the öoze and bottom of the deep. No customers are *there* for Manchester cottons or Lyons silks; gold from California and Yankee greenbacks in those cold green depths would be alike at par; and even a cargo of POPULAR SCIENCE REVIEWS would find no readers amongst the foraminifera and star-fishes of the ocean floor. We have said such a ship never could be meant for any good. Nor is she. Her designer, M. Baüer, intended her solely to play mischief with other ships, and to plant torpedos for blowing up an enemy. Such a vessel has been actually constructed, we believe, in our own dockyards, and practically worked at one hundred feet under water for two hours; but the close of the Russian war rendering the use of such amphibious craft no further necessary, the public have heard little or nothing about her; although it is said that Lord Palmerston and the late Prince Albert took great interest in the matter.

M. Baüer is, we believe, a Prussian; and it is, we are informed, upon his plan that the Russian Government are now constructing a submarine vessel at the cost of £27,000: we are much disposed to think, however, that for want of complete development this vessel may not answer, but there is no doubt that English engineers could construct submarine vessels capable of remaining under water from ten to twenty hours at depths not exceeding 120 feet. Such vessels might be of any size, and would be capable of effecting an enormous and unheard of amount of mischief.

The designs for such a vessel would be kept as secret as possible; but the general fundamental principles may be easily explained. Suppose an iron vessel. She floats because her entire internal cubical capacity being filled with air, her weight displaces a less bulk of water than her own dimensions. Now close up every hatchway and entrance; hermetically seal in, as it were, the air; and leave only a pipe and valve by which the *exit* of any of the contained air may be controlled or stopped altogether. Open the valve. Now, by means of another valve, let into her hull water from the sea. As the water comes in the air is pressed out. She begins to sink, goes gradually down,—ten, twenty, forty, fifty, a hundred feet. Shut up the air-valve; shut up the water-valve. She is exactly now of the same specific gravity as the water in which she is submerged. She will not rise; she will not sink. Set the engines at work upon her screw-propeller. She progresses. Through thick glass bull's-eyes in her decks, men watch the sea-scape above them. The dark bottom of some huge ship blots out the dim light from above. The "submarine" is lightened, rises slowly; submarine sailors in submarine helmets and clothes come on the submarine deck, the torpedo is fastened to the great sea-castle's keel, the fine copper wires are carefully uncoiled, the submarine fiend-ship sinks down again, gently screws back a short distance out of danger. The subtle battery is connected with the wires, and the great roar of the explosion but dimly reverberates through those silent depths; the splash of the hundreds of mangled bodies is neither heard nor seen. How will this submarine monster rise or sink after her first delicate adjustment to the slightly denser water to which she has gone down? How can her sailors continue to live and breathe in the impure closed up hull? Very well indeed. Did you ever try to compress water? You could not do it. Of the greatest volume you ever tried you could not get a perceptible compression. But you can compress air. You have used it in your air-gun. Well, you can compress air to the pressure of 500 lb. to the square inch; it has been compressed more than this, a great deal more. Now, air at 500 lb. pressure to the inch is air at the pressure of more than thirty-three atmospheres; that is to say, every cubic foot of this compressed air will expand when let out into nearly 34 cubic feet. So the air in a cabin 10 feet square could be entirely replaced thirty-three times by a thousand cubic feet of compressed air at this pressure. The compressed air then is taken down in the submarine vessel in pipes, and let out by valves as required.

The life of the men can be supported, and the weight of the vessel adjusted to the density by the water around her, as long as a single foot of compressed air remains. When her stock is nearly exhausted she would be brought of course to the surface—her engines would be worked to condense more air—and having taken fresh breath she might take other under-water excursions, until her captain put an end to her voyages, as we intend now to do to this chapter.

EXPLANATION OF PLATE I.

Fig. 1.—The "Cigar-ship." *a b*, the end cones; *c d*, the raised deck; *e f*, the screw-propellers.

Fig. 2.—The "Connector-ship."

GOOD FOOD.

BY EDWIN LANKESTER, M.D.

MAN, in his wild and barbarous state, like the lower animals, is enabled by his instincts to obtain from the external world those substances which, under the name of food, maintain his existence. It is as he advances in civilisation, and becomes more and more dependent on his intelligence, that he is obliged to use his reason, and to select those foods which are best adapted to the new circumstances in which he is placed. Thus in a wild and semi-barbarous condition, large quantities of food are easily consumed which are utterly incompatible with the health of man in a more civilised state. We also find that man in his civilised condition, by his power of consuming a variety of foods, is enabled to ward off many diseases which rapidly destroy the life of those who are in a barbarous condition. The fact that the civilised races of Europe are less exposed to plague and other pestilences, to scrofula, and many other wasting diseases, depends as much or more on a due supply of healthy food than on all other causes put together. How such beneficial effects are produced it will be the object of this paper to show, by an explanation of some of the laws which govern supply and demand with regard to food in the human system.

If we carefully study the nature of our daily food, we shall find that it is by its agency that all the functions of our body are carried on; that by the aid of fresh supplies of food we live. It is an easy experiment that will satisfy of this fact. If we get up in the morning and go to our work without breakfast, continue it till dinner-time without partaking of that meal, and go to bed without supper, we shall find how thoroughly all mental and bodily exertion depends upon our food. If we performed this experiment, and weighed ourselves in scales from hour to hour, we should find that we were growing "small by degrees;" and should we withhold nourishment for a sufficient length of time, death would most certainly ensue.

If we examine a little more closely this question of food, we shall find that the chemical elements of the food we take are precisely the same as those of the body. I have calculated that a human body weighing eleven stones, or 154 pounds, contains the following compounds and elements :—

COMPOUNDS.

	lb.	oz.	gr.
Water	111	0	0
Gelatin	15	0	0
Fat	12	0	0
Albumen	4	3	0
Fibrine	4	4	0
Phosphate of Lime	5	13	0
Carbonate of Lime	1	0	0
Fluoride of Calcium	0	3	0
Chloride of Sodium	0	3	376
Chloride of Potassium	0	0	10
Sulphate of Soda	0	1	170
Carbonate of Soda	0	1	72
Phosphate of Soda	0	0	400
Sulphate of Potash	0	0	400
Peroxide of Iron	0	0	150
Phosphate of Potash	0	0	100
Phosphate of Magnesia	0	0	75
Silica	0	0	3
	150	0	0

ELEMENTS.

	lb.	oz.	gr.
Oxygen	111	0	0
Hydrogen	14	0	0
Carbon	21	0	0
Nitrogen	3	8	0
Phosphorus	1	12	190
Calcium	2	0	0
Sulphur	0	2	219
Fluorine	0	2	0
Chlorine	0	2	47
Sodium	0	2	116
Iron	0	0	100
Potassium	0	0	290
Magnesium	0	0	12
Silicon	0	0	2
	154	0	0

Now I do not claim for these quantities anything more than a rude approximation to the truth; but as no one has yet analysed a whole human body, we may take these calculations as representing the composition of a human body.

Now these substances are not fixed in the human body. They are all of them constantly undergoing chemical change, and the result of this chemical activity is what we call life. One of the necessary conditions of the life of the body is that it be placed in an atmosphere containing oxygen gas. Our atmosphere contains 79 parts of nitrogen and 21 parts of oxygen in every 100. This oxygen is being constantly taken into the human body. If we prevent the oxygen getting into the lungs by hanging, drowning, or any other process, the person is suffocated. It is the oxygen which consumes the body. Just as a burning candle is consumed in the air, so is the human body. The oxygen attacks the carbon in the system and forms carbonic acid; it unites with the hydrogen and forms water. It has been calculated that twenty-four ounces of oxygen are every day taken into a human body weighing 154 pounds. This oxygen does not remain in the human body, but comes away from it again in the form of carbonic acid gas, which is thrown from the lungs. Twenty-four ounces of oxygen will unite with eleven ounces of carbon to form thirty-five ounces of carbonic acid, and this is the source of the diminished weight of a human body when no food is taken.

In addition to this, I calculate that there passes from the body one hundred and three ounces of water; fifty-one by the kidneys, thirty-one by the lungs, sixteen by the skin, and five by the alimentary canal. In addition to the water, there are dissolved in it two ounces and a half of soluble salts, including urea (a substance containing nitrogen), and about two ounces of insoluble matter. In all, a body weighing one hundred and fifty-four pounds loses every day about one hundred and forty-three ounces.

In living, moving, and acting, then, the human body loses about a sixteenth of its own weight every day. The supply for all this waste is food. The necessity for food is this waste. If we examine the composition of food we shall find that it has in it the same compounds and the same elements as we find in the human body. If we place all the variety of foods which man consumes, from his first meal in the morning to the last at night, under chemical analysis, we shall find that they only contain the elements of his body. Nay, four of these are so prominent above all the rest that recent writers on dietetics confine their attention principally to these four, namely,—carbon, hydrogen, oxygen, and nitrogen. In a body weighing one hundred and fifty-four pounds, they form one hundred and forty-nine pounds and a half.

We now begin to see how science is teaching man the difference between bad and good food. That food alone is good which has a proper quantity of each of the elements of which the body is composed. It must not, however, be supposed that the immediate destination of the food is to be carried into the blood, and there to undergo the changes which result in the waste to which we have referred. No; the food is first taken into the stomach, and there undergoes physical and chemical changes which fit it to become blood. The blood supplies all the organs with the new matter, and receives from them the old, effete, or used matter, which is the portion of the body that becomes waste and passes from it. The body is thus hourly, nay constantly, being built up and taken down. The physical and chemical forces, acting on particles of matter too minute for even microscopic vision, are perpetually performing this great work, and the grand result of this perpetual activity is life. It is thus that the body in which we live is perpetually passing away. It changes from hour to hour and from day to day. Some portions of the body pass rapidly away, as the muscles, nerves, and soft parts generally; whilst others, as the skin, the nails, the hair, and the bones, more slowly change. But, on an average, it would appear, of about forty days, the whole body disappears. The mould remains, the consciousness of existence remains, some kinds of inorganic matter, accidentally introduced, remain; but the great bulk of the material particles of the body have in that time all passed away. We pass to our graves many times before the last mass of particles of which we are conscious as our body is carried to its tomb.

Although our food consists of the same ultimate elements, and these are arranged frequently into the same compounds as our bodies, it nevertheless assumes a variety of forms which admit of tolerably precise arrangement and classification. Some substances used as food are distinguished by containing large quantities of water; others present us with carbon or nitrogen as their distinguishing ingredients; whilst others, again, exert a medicinal action on the system, or are comparatively inert.

The kinds of food which are most necessary to life, and most abundantly taken, are those which contain more or less of the four organic elements, carbon, nitrogen, oxygen, and hydrogen. Of these four elements, the carbon and the nitrogen are the most important. Carbon, which, in its pure state, exists as animal or vegetable charcoal, graphite or blacklead, and the diamond, is an inflammable substance, and, as we have already stated, is constantly combining with oxygen in the body, and forming carbonic acid. It is principally by its agency that the heat of the body is maintained. It exists in all the more common articles of our food, more especially in those substances known by the name of starch, sugar, and fat. We shall therefore speak of these substances separately.

Starch is universally present in the vegetable kingdom. It exists in the cells of plants, in the form of minute granules, varying from the $\frac{1}{3000}$ to the $\frac{1}{10000}$ of an inch in diameter. It is contained in wheat, barley, oats, rye, rice, maize, and potatoes, and constitutes almost the entire substance of sago, tapioca, and arrowroot. We thus see how largely it enters into the composition of our daily food. Chemically, it consists of seventy-two parts of carbon and ten parts of water. Starch is insoluble in water; but, when mixed with saliva, it is converted into sugar, and thus becomes soluble. Starch does not enter the system unless it is first converted into sugar. The value of starch as a food depends on its introducing carbon into the system. Starch, then, is one of the means by which carbon is introduced into the system, and is called on that account, by Liebig, a heat-giving food.

Starch, in the plant, is constantly converted into *Sugar*, and sugar is taken by man as food, as it saves him the trouble of converting starch into sugar. It is contained in many plants, especially in fruits; but it is separated from the sugar-cane and other plants, and used by man in its pure state. It supplies carbon for the animal stove, and is justly regarded as a heat-giver.

Starch and sugar are converted in the vegetable system into fat by the loss of their oxygen. Fat contains large quantities of carbon and hydrogen, and but little oxygen. The consequence is that when fat, in any form (whether what we call butter, lard, suet, or oil), is introduced into the system, it offers hydrogen as well as carbon for combination with oxygen. For the purposes of maintaining animal heat one pound of butter or oil goes as far as two pounds of sugar or two pounds and a half of starch. It frequently happens in the animal system that, when the carbon of the sugar and starch is not required for animal heat, they lose their oxygen and become converted into fat. In this way they are deposited in the system, and animals fed on an excess of starch and sugar become fat. In the summer season, when the animal system has less demand for heat, herbivorous animals become fat. Man himself becomes fat at this season by consuming the usual quantities of starch and sugar. This is a point of great practical importance to those who do not wish to become fat. It is not only necessary that they should not consume fat, but that they should not consume those substances which contain starch and sugar, and which, if taken in larger quantities than suffice to maintain animal heat, are converted into fat.

Fat and its analogues, butter, suet, and oil, are not only taken as a means of supporting animal heat, but are found essential to the development of some important tissues. Muscles and nerves cannot form without fat. Hence it is that in those states of disease where wasting of the tissues occurs, one of the best possible remedies is fat; and so important is this, that the introduction of animal fat, in the shape of cod-liver oil, has been found one of the most important remedies in all cases of wasting disease.

On the other hand, there are deranged conditions of the system in which the sugar and fat are not oxidised, but are deposited in the form of adipose tissue in the system. This adipose matter either accumulates from this cause, or from the too free ingestion of sugar and fat. The remedy in the latter case is simply to stop the supplies; the treatment in the former case demands more inquiry, and consists in the removal of any impediment which may exist to the free oxygenation of the carbonaceous materials.

A second group of foods are those which, in addition to carbon, hydrogen, and oxygen, contain *Nitrogen*. The nitrogen does not exist in these substances in large quantities, but it is a distinguishing ingredient. We have seen that two substances exist in the body called fibrine and albumen, the former entering into the composition of the muscles, the latter that of the nerves. Now these substances are contained in our vegetable food, and it appears that they are directly conveyed from the vegetable to the animal. We have no knowledge of any power in the animal system to manufacture these substances. All the nitrogen which is contained in an animal is derived from the vegetable kingdom. It is the peculiar property of the plant to be able, in the minute cells of which it is composed, to convert the carbonic acid and ammonia which it gets from the atmosphere into fibrine and albumen. By easy chemical processes we can separate these substances from our vegetable food. Wheat, barley, oats, rye, rice, all contain fibrine, some of them also albumen. Potatoes, cabbages, and asparagus contain albumen. It is a well-ascertained fact that those substances which contain most of these "nutritious secretions" as they have been called, support life the longest. Liebig calls them "flesh formers." They undergo little change during digestion, and present themselves in a pure state in the blood, where they are directly employed in the renewal of nervous and muscular matter. They are the agents which renew the thinking and working powers of man. They are probably destroyed at the same moment that the carbon is converted into carbonic acid gas, but in their last stage they pass off from the body in the form of urea. The nitrogen lost in the destruction of the fibrine and the albumen is found in the nitrogen of the urea. Mere existence is represented by the loss of carbonic acid, but the work of the system in its thought and its muscular labour is represented by the nitrogen of the urea. Nor is this the mere dream of the theorist: it has been practically demonstrated that increased stress upon the nervous system, viz., brain-work, emotion, or excitement from disease, increases the quantity of urea and the demand for nitrogenous food. In the same manner the amount of urea thrown off is the representation of the amount of muscular work done.

Important as these two groups of food are, they do not exhaust all that is necessary to constitute "good food." In addition to the compounds of the four organic elements, the human body requires certain saline constituents, without which it cannot exist. These are the five pounds of phosphate of lime, the pound of carbonate of lime, the three ounces of fluoride of calcium, the three ounces and a half of common salt, with the other salts. They are all passing off from the body at the rate of about one ounce in the twenty-four hours.

It is not much; but then it must be supplied, or disease, dire and fatal, sets in. It will not do to supply one salt for another. Spare the lime salts, and the bones give way, and rickets, crooked spines, and feeble bones are the result. Give up eating salt, and the blood suffers, the cheeks get pale, the liver refuses to perform its functions, and the frame goes to rack and ruin. Eat as much lime and soda as you will, the muscles will fail to do their duty without potash. Scurvy sets in, and all its frightful consequences are the result. But how are we to know where to get these things? With the exception of common salt they are none of them brought to the table. I think they might be brought to the table; a mixture of the phosphate of lime, and soda, and the chloride of sodium and potassium, might be added to our food in such a way as to secure a due supply. But even the nineteenth century Englishman is not sufficiently civilised to act upon his reason at present, and therefore no attempt will be made to introduce them directly into the system, although they can be demonstrated to be necessary. In the meantime we may comfort ourselves by a knowledge of the fact that all our vegetable and animal food contains a certain quantity of these mineral constituents. If we turn to tables of analyses of various kinds of food, we find that in every pound wheat contains a quarter of an ounce of mineral matter; potatoes, the eighth of an ounce; and cabbages, lettuces, watercresses, fruits, and especially tea, contain large quantities of these mineral matters. So that we really get them in our ordinary food; but we may have them in too small quantities,—especially may they be deficient in boiled food, unless the water in which it is cooked be taken in the form of broth or soup. I especially recommend to my countrymen the practice of habitually taking soup, which contains dissolved in it mineral substances. To soup should be added fresh vegetables of any kind that are in season. The practice of eating salads and uncooked fruits every day is to be highly commended for the same reason. The beneficial effects of the potato as an article of diet are more to be attributed to its mineral than other constituents. To banish potatoes from the diet without substituting other vegetable food, is to invite the most destructive diseases to which the human frame is liable.

Amongst the mineral constituents of our food must be placed water. One hundred and eleven pounds out of the hundred and fifty-four of a human body is water. We are not so completely organised water as jelly-fishes; but we are, nevertheless, exceedingly watery beings. The water of which our bodies are composed passes away at the rate of one hundred ounces a day; and if we drink largely, larger quantities are accordingly given off from the various excretory organs. Water is contained in all our solid food. More than half the bulk of our meat, bread, and vegetables is water. Water is therefore one of the most important constituents of our food. Everything we take is first dissolved in it before it can be taken up and get into the blood; and none of the tissues can grow up, and be taken down to serve the purposes of life, without its agency. It is the great primal substratum of organic life, with which the organic and other elements are worked, for the purpose of producing all the forms of animal and vegetable life. Of all the constituents of the body it alone remains unchanged. It flows through our life like a tide, and our bodily forms are, as it were, reflected from its surface by their physical properties, even as the sun produces the perfectly formed rainbow from the falling waters of a cataract.

There is yet another group of substances entering our food that demand attention. They are not taken for the purpose of promoting animal heat, nor do they take a part in the fabric of the body. They simply address themselves to the nervous system, producing, either directly or indirectly, agreeable impressions. Some of them are employed to season food, and address themselves to the palate. Such are the various forms of condiments, spices, and flavours. Others act upon the nervous system after they have entered the blood, and produce their effects upon the brain and spinal cord. Such are theine, contained in tea and coffee; alcohol, contained in wines, spirits, and beer; nicotine, in tobacco; and morphine, in opium. It is impossible to exclude the consideration of these things in estimating the nature of "good food," although many of them have been regarded as having no claim to the title of food at all. I have elsewhere called them medicinal or auxiliary foods. We may dismiss the consideration of condiments, spices, and flavours, in a few words. They may be used or not, at pleasure, and, where food is otherwise good, no especial need for them is felt. At the same time, they are extensively employed, and wherever man is rescued from the barbarism of eating merely heated food, there condiments and spices will be employed. Scarcely any human act is a better index of civilization and culture than the care taken in the preparation and flavouring of food. The careless preparation of food is at once wasteful and unhealthy. It leads to the destruction of that which is available for the life of the body, and produces those diseases which, commencing with indigestion, end with fevers, brought on by an unhealthily constituted blood.

There are three things in this group of substances which demand a word or two of notice. These are theine, alcohol, and tobacco.

Theine is a compound formed in tea and coffee, and which can be separated in the form of white crystals. When given to frogs it speedily paralyses and shortly after kills them. It therefore undoubtedly acts on the nervous system, and it is probably this paralysing or sedative action that commends theine to the busy, excited populations of Europe. It should, however, be remembered that it is a poison, and may be taken to excess. I have known many instances of severe dyspepsia and a long train of nervous symptoms immediately disappear on the suspension of tea and coffee.

Alcohol is another substance which addresses the nervous system. It first excites and then depresses and overcomes. It has been the great tempter and curse of man since the days of Noah. It has been hailed by poets and praised by prophets, and, again, driven from society as a devouring beast. It may, perhaps, be safely advanced that, with his present tendency to abuse this substance, man would be better without it. Nevertheless, if guided by reason, it may be made by man an alleviation of his sorrows, a protection to his health, and a harmless contribution to the pleasures of his social meals. The great question is, how much may be taken from day to day with impunity. Without going into any question of its action on the system, whether it is partly burned or all got rid of by the secretions, I would say that my experience is that a healthy man, taking open-air exercise every day, cannot safely consume more than two ounces of alcohol daily. Roughly, this quantity is represented by a pint of strong ale, or a quart of London porter, or four glasses (or eight ounces) of port or sherry, or eight glasses (or sixteen ounces) of hock or claret. More than this may be excess; but every man should be the judge of his own requirements. When alcohol affects the head, or produces thirst, or deranges the stomach, or liver, or kidneys, it should be given up or reduced. There is no doubt, however, on my mind that men, women, and children can maintain their health through long periods without having recourse to alcohol at all.

Tobacco cannot be regarded as a food at all: at best it is but an indulgence. Nevertheless, indulgence is lawful, and the question comes as to what injury is inflicted on the system by tobacco. Like other narcotics, it obeys the law that, if a second dose be not taken till the effect of the first is gone off, it can produce no permanent injury on the system. Tobacco-smoke has not the power which alcohol possesses of destroying the tissues and interfering with the nutrition of the body, and consequently, even when taken to excess, does little harm as compared with alcohol. Its allurements for mankind have been much more universal than even alcohol. With the exception of a few European and American women, the whole human family smokes. If it be a vice, its evils are so small and its fascinations so great, that it may most certainly be prophesied that it will be one of the fixed habits of humanity for all time to come.

Leaving, then, the last two groups of food, let us consider the first two groups, those which comprise the great bulk of our aliment from day to day. In order to the understanding of this subject, I have drawn up a table of the daily supply and waste of a human body, weighing eleven stones and measuring five feet eight inches in height.

TAKEN IN.		OZ.	GIVEN OUT.		OZ. GR.
I.—*Gases.*			I.—*Gases.*		
Oxygen		24	Carbon ...	11 oz.	
			Oxygen ...	24	
II.—*Liquids.*				—	35
Water :—					
In beverages	68 oz.		II.—*Liquids.*		
In solid food	25		Water :—		
	—	93	By kidneys	51 oz.	
			By lungs ...	31	
III.—*Solids.*			By skin ...	16	
Flesh producers :—			By alimentary canal ...	5·237	
Fibrine ...	3 oz.			———	103·237
Albumen and caseine ...	1				
		4	III.—*Solids.*		
			Insoluble		2
Heat-givers :—			Soluble :—		
Starch ...	12 oz.			oz. gr.	
Fat or butter	5		Urea ...	1·200	
Sugar ...	2		Salts ...	1	
	—	19		———	2·200
Indigestible :—					
Gelatine ...	1 oz.				
Cellular ...	1				
	—	2			
Mineral matter ...		1			
		143			143·000

This analysis has been founded upon an extensive analysis of the dietary of soldiers, sailors, prisoners, and the diet of the better-paid class of artisans and professional classes in London.

The solid substances named in the "taken in" list are found in the common articles of diet, in the meat, the bread, the flour, the vegetables, the cheese, the butter, the sugar, that we take at our ordinary meals. It will be seen that the proportion of heat-givers to flesh-formers is as five to one; but if we include the indigestible and innutritious matters—the gelatine and the cellulose—as is usually done—with the flesh-formers, then the proportion of the heat-givers is about four to one. It must, however, be always recollected that, in attempting to frame a diet by weight, some substances are less digestible than others, and therefore cannot be relied on as food at all. Unmasticated starch passes through the alimentary canal without change. Coarse, tendinous meat is frequently not digested at all. Woody matter, cellulose of plants, is not digested at all. Cheese, though containing large quantities of caseine—a substance resembling albumen—is very indigestible in its hard state, though easily digestible in its fresh and soft state. The consideration of the *digestibility* of food is of the utmost importance, without which our best-framed dietaries may fail of their end.

There is one result of diet that is at the present day exciting a large amount of public interest, and that is the tendency of the adipose tissue to become developed to such an extent as to interfere with freedom of motion and other healthful actions of the system. The tendency to deposit fat is undoubtedly a peculiarity of some individuals of the human race, as well as of whole races of the lower animals. The breeds of sheep, pigs, and oxen that fatten fastest are most valued for the meat market. This property more often depends on a power of consuming large quantities of heat-giving foods than on any other state of the system. It is generally, therefore, a very easy thing to reduce corpulent persons, by restraining them in the indulgence of heat-giving foods. Eat no butter at breakfast and no bread at dinner is a recipe which, when scrupulously followed out, I have generally found act favourably on stout persons. An intelligent apprehension of the general facts I have mentioned will enable persons of a little energy to reduce themselves when and as much as they please. It is, however, a dangerous practice to attempt to reduce corpulent persons by empirical means. Strong exercise, sweating, vinegar, solution of potash, and abstinence from all kinds of heat-giving food, are alike dangerous, and must sooner or later end in disease or some fatal catastrophe. On the subject of reducing corpulence Mr. William Banting has given an instructive and amusing account of his own experience in a letter which he has published. Although not very corpulent, the adipose tissue had collected in those parts of the body which interfered with the circulation, and in the course of a few weeks, by discontinuing a most injudicious and unlimited dietary for one which his medical man had the great judgment to prescribe by weight, he soon lost his fat and the inconveniences that attended its presence. It would, however, be highly injudicious for any person, unless placed under the same circumstances, to follow Mr. Banting's course of diet.

The diet he pursued,—for every one who knows anything about diet must hope he is not still pursuing it,—is objectionable from many points of view. Thus, excepting salmon amongst fish, and pork amongst meats, is fanciful. Salmon contains less fat than many fish, and lean pork is not so fattening as fat mutton. The exclusion of milk from the diet is also objectionable, as milk conveys, in the most digestible form, nutritive matter to the system. Again, the exclusion of potatoes from the diet is a great mistake, as they contain mineral elements that are not so abundantly supplied from other sources. Why champagne and port are excluded from the wines, whilst sherry and Madeira are admitted, would puzzle those who looked at the dietary from its anti-pinguidaceous point of view. There is no reason in excluding beer, if ten or twelve ounces of wine be allowed. Provided a man be not of active habits, a dietary like this might quickly plunge him into evils to which those of corpulence are a mere trifle.

At the same time there can be no doubt that Mr. Banting has been reduced by the withdrawal of starch, sugar, and fat from his dietary. He complains that no one ever thought of this in his case till the year 1862, when he began to reduce himself. He will, however, find ample directions given for the reduction of obesity in an article on that subject which I wrote for the *English Cyclopædia* in 1859, and which was only the result of my teachings in my lectures on dietetics for the foregoing fifteen years.

The question, however, of fat accumulating in particular parts of the body so as to produce disease is quite a different one to that of corpulence. Many corpulent persons enjoy excellent health, and I strongly recommend them to let well alone. It is, however, a desirable thing when persons are suffering in health to know really what men ought to weigh. We are indebted to the late Dr. John Hutchinson for weighing above two thousand six hundred men at various ages. Having worked with Dr. Hutchinson in the early part of his researches, I was struck with an obvious relation between the height and the weight of the persons he so pertinaciously weighed and measured, and I discovered that, starting with the lowest men in his tables, it would be found that the increase of weight was as nearly as possible five pounds for every inch in height beyond sixty-one inches. The difference between the observed height and weight and the calculated weight will be seen in the following table:—

Height. Inches.	Observed Weight. lb.	Calculated Weight. lb.
61	120	120
62	126	125
63	133	130
64	139	135
65	142	140
66	145	145
67	148	150
68	155	155
69	162	160
70	169	165
71	172	170
72	176	175

This is so generally true, that in the course of many years' observation I have seen only a few cases in which an excess upon these weights could be attributed to any other cause than an excess of adipose tissue. To the medical man these tables will be found of advantage, as guiding him in giving dietetical advice in certain cases of disease.

Whilst the excessive supply of heat-giving materials in diet is likely to engender corpulence and its attendant evils, it ought to be recollected that the withholding a due supply of these substances is likely to be very injurious. It has been found that a certain quantity of fat is a necessary addition to all dietaries. It enters into the food of all peoples, and exists in small quantities in all kinds of vegetable food. It has been found deficient in the body in certain wasting diseases, as consumption; and the most efficacious remedy in this disease is an animal oil, which, being easily digested, speedily supplies the system with the needed fat. Articles of food containing fat may be efficiently used as substitutes for cod-liver oil. Thus for children I am in the habit of recommending cream and cream-cheeses. The latter soft and digestible form of food is, I believe, too much overlooked in the diet of the scrofulous and consumptive. The use of salad oil and fat meats is also to be recommended under the same circumstances.

If it be important to regulate the supply of the heat-givers, it is not less so to supply the flesh-formers. To diminish these and under-supply the body, is to tax the muscles, to tax the heart, to tax the brain. It is to let the system down till one or other of its complex arrangements goes wrong and death results. I have said that four ounces of these precious constituents of our life are necessary. They form the substance of muscle and nerve, the foundation of all handwork and headwork. Just in proportion as we work with our heads and hands do we require these flesh-forming matters. "On what principle do you discharge your men?" I once said to a railway contractor. "Oh," he said, "it's according to their appetites." "But," I said, "how do you judge of that?" "Why," he said, "I send a clerk round when they are getting their dinners, and those who can't eat he marks with a bit of chalk, and we send them about their business." Quite right, Mr. Contractor. No man can work without eating; but he must eat fibrine, albumen, and caseine. Instinctively the navvey and the author find out the food that contains most flesh-forming matter. But it is fathers and mothers, and masters and mistresses, who feed others by rule, that should know the nature of "good food." Above all, it is the Government of this country, which feeds soldiers, sailors, paupers, and prisoners, that should know these things. After an examination of the public dietaries of this country, I have no hesitation in saying that the knowledge of what is good and proper food is much greater amongst the public generally than it is amongst our Government officials. No doubt, great improvements are taking place, but many of our public dietaries are at the present moment little short of being disgraceful.

The question, then, comes as to the best way of supplying the needed four ounces of flesh-forming matter. Any table of food analysis will show us approximately how this may be obtained. It is contained in a pound of beef; in two pounds of eggs; in two quarts of milk; in a pound of peas; in five pounds of rice; in sixteen pounds of potatoes; in two pounds of Indian meal; in a pound and a half of oatmeal; and in a pound and three-quarters of flour. But it would be highly injudicious to give any of these things continuously. The system seems to delight in variety, and the constant supply of the same food day by day becomes disgusting and is dangerous to life.

Of all substances used as food which can be longest borne, and is freest from objection, is milk. Milk is the natural diet of the young; it contains all the elements of the nutrition of the body; it supplies the deficiencies of other articles of diet; and when it cannot be got both young and old suffer, but especially the young. Wheaten bread, next to milk, can be longest endured as a single article of diet; but men would starve on bread alone. Hence the necessity not only for quantity, but for variety, in food. Variety will not, however, make up for quantity: where there is not a supply of twenty-eight ounces a week of flesh-formers there is under-feeding; under-feeding means starvation. This is a question of national importance. It is vain to expect either brain or muscles to do efficient work when they are not provided with the proper material. What fuel is to the steam-engine, "good food" is to the human machine. Neither intellectual nor physical work can be done without "good food."

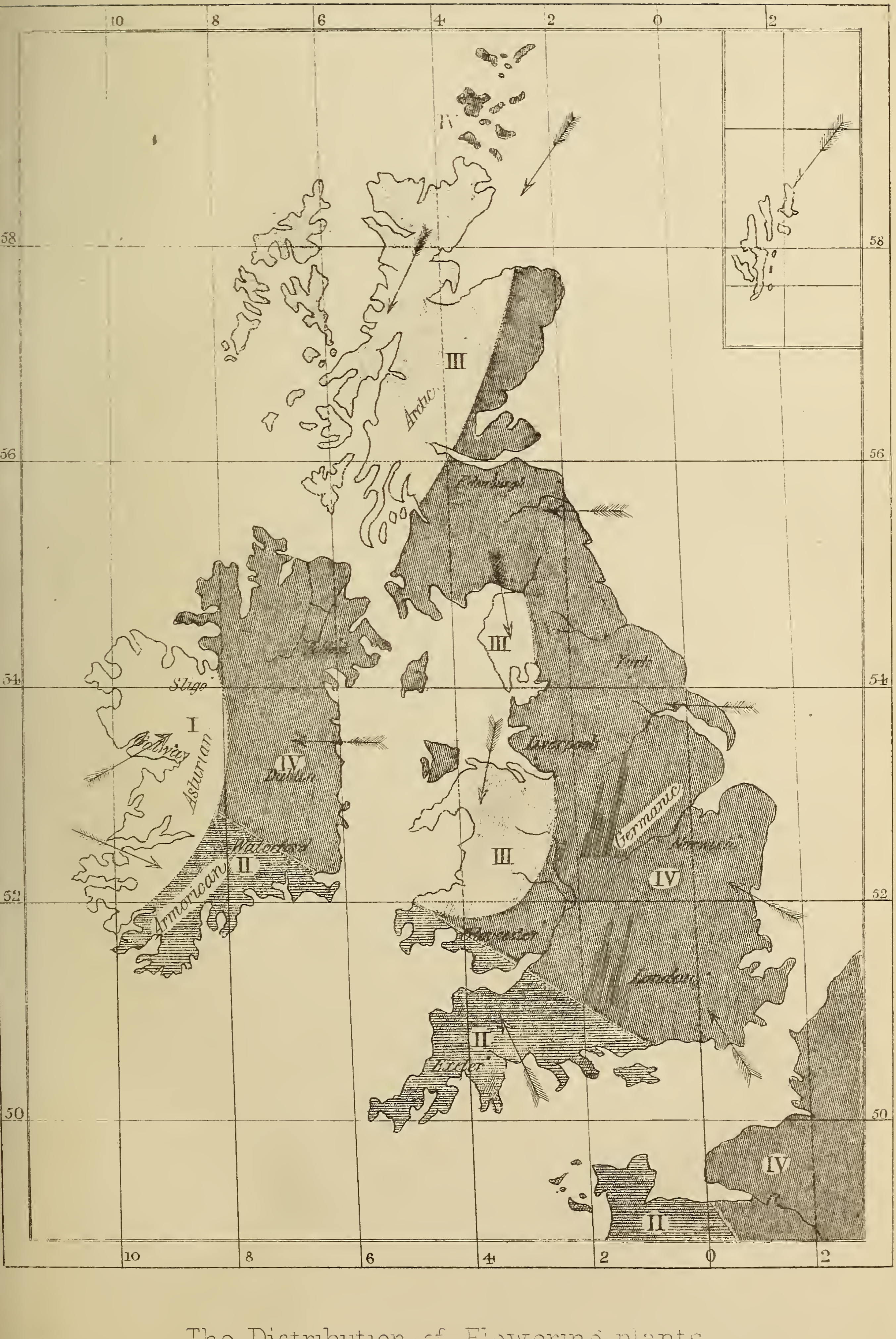
ON THE ORIGIN OF THE LOCAL FLORAS OF GREAT BRITAIN AND IRELAND.

BY HARLAND COULTAS,

LECTURER ON BOTANY AT THE CHARING CROSS HOSPITAL.

THE botanical evidence from fossil plants proves irresistibly that the present vegetable creation has been preceded by many others,—is continuous with them and the product of their labours,—is, in fact, only a fragmentary portion of that vegetable carpet with which nature has covered the earth during the successive periods of its geological history, and the pattern of which has been continually improving in beauty and variety. Fossil plants may be truly regarded as the remains of a system of vegetable life developed under external conditions, which are no longer the same in any part of the world. The calamite, lepidodendron, and other extinct forms of vegetation, on which our sun once shone, have at last disappeared for ever, as living agents, from the surface of our planet. They probably could not exist in the present world; but they helped to carry on the work of creation whilst they did. And the same remarks apply to the present living plants, all of which are contributing their part to the advance of nature, and are just as well and beautifully adapted to this stage of the world's progress.

The most important fact taught by fossil plants is that the organic and inorganic creation has *slowly* assumed its present appearance, and the evidence leads us to the unavoidable conclusion that changes have taken place in the organization of plants by which their forms have been gradually adapted to the ever-changing landscape. The history of the origin of the local floras of the British isles is, therefore, intimately associated with the history of those physical changes which have brought about, slowly, their present geographical figure and position with reference to the continent of Europe. The history of these past changes, in so far as it tends to explain the present character and distribution of British plants, is a legitimate inquiry, fairly open to botanists and geologists. At present these changes are only imperfectly understood or traceable; but every succeeding year adds to the store of facts



The Distribution of Flowering plants

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already accumulated, and from the progress that has been already made, investigations of this nature would seem to be quite within the scope of human inquiry and successful scientific research.

It is obvious that all hypotheses which aim at connecting the present with the former state of things, to be valid and satisfactory, must be founded on correct data in geology and palæontology. Professor Forbes was the first to lead the way in these difficult and interesting explorations, in his essay "On the Connection subsisting between the Distribution of the existing Fauna and Flora of the British Isles, and the Geological Changes which have affected their Area, especially during the Epoch of the Northern Drift."

Some islands possess a flora peculiar to themselves, and form distinct centres of vegetation, whilst others contain only the plants common to the nearest continent. The latter is the case with Great Britain, Ireland, and the adjacent isles, which, with one exception, are stocked with the plants of the adjacent continent of Europe. The exception is *Eriocaulon septangulare* (jointed pipe-wort), found only in the Hebrides, and Connemara, in the west of Ireland, and not known elsewhere in Europe. It is a North American plant, and has no doubt been introduced naturally into the British isles, by means of "transport, now or anciently in action."

The British isles have been explored by geologists, and they have discovered indications which amount to positive proofs that they were formerly united to Europe. England makes the nearest approach to the Continent at Folkestone, in Kent, which is not more than twenty miles distant from Cape Grisnez on the coast of France. The former union of the two countries by an isthmus, which has been wasted away by the denuding force of the waves, is indicated by the shallowness of the intervening strait, the proximity and identity in mineral composition of the opposite shores and cliffs, whether flat or sandy, steep or chalky, and the occurrence of a submarine ridge, running across the channel.

According to Professor Forbes, there are three modes in which an isolated area may become peopled by plants and animals.

1. "By special creation within the area.
2. By transport to it.
3. By migration before isolation."

As to the first of these modes, it is unnecessary, for, as the plants of Great Britain are, with the single exception already mentioned, all identically the same as those in Europe, there is no occasion to account for their existence in England and Ireland by the theory of their "special creation within the area," especially as we know that England and Ireland were formerly united with each other and with the Continent.

The second of these modes is not sufficient. For, although we should allow that all the British cryptogams, mosses, ferns, &c., and some of the phænogamous plants may have been able to cross the seas after the separation of these islands from the Continent, yet, after making every allowance for all existing means of transport, there still remain a number of species of animals and plants which it is impossible should have found their way to their present stations by any causes now in action. The nature of their seed, and certain bodily characteristics and peculiarities in their distribution, prevent us from entertaining such an idea. We are thus driven to the last consideration, "migration before isolation," and we must seek for further information in geological inquiries. In fact, the present state of geology and natural history obliges us to regard our flora as constituted of plants of a different date and origin. They must all be referred to geological epochs more or less ancient.

The probable great antiquity of all our plants, under their existing forms, impressively suggests itself from the following facts and considerations.

There are trees now in England whose great age cannot be doubted. Oaks, which were planted before the time of the Norman invasion, and which are therefore more than 800 years old. The yew-trees (*Taxus baccata*) are still older. One still growing at Fountains Abbey, near Ripon, in Yorkshire, was examined by Pennant in 1770, and was then more than 1,200 years old; and another, in the churchyard of Braburn, in Kent, according to the measurement of Evelyn, in 1660, had then attained an age of 2,880 years, and consequently is now more than three thousand years old. Now we know from experience that the same specific forms of herbaceous plants have been continued for several generations. Apply this to ligneous species, such as the oak and the yew, and suppose these old English oaks and yews to have been preceded by only twenty generations of the same species,—and why should we not?—and you get for the oak form an antiquity of 16,000 years. But if our readers hesitate to accept this, then we must remind them of those famous foreign trees, the mammoth pines of California and the Baobab of Africa, which are known to have been in existence for several thousand years. If we limit the number of preceding generations of these trees to only four, then the prior existence of the species must be immediately dated back 12,000 years for the California pines, and for the Baobab, which is upwards of 5,000 years old, 20,000 years!

All our cereals, such as wheat, barley, rye, oats, are annuals, and have to be raised every year from seed. But we have historical evidence that man has cultivated them for upwards of two thousand years, and also that the species has not changed during the whole of that period. The present crops have therefore been preceded by 2,000 generations of the same species. Now suppose an equal number of generations of oaks and pines to have preceded those at present growing in England—and what is there unreasonable in such a supposition?—if we give to each generation only an average duration of 100 years, then we get a period of 300,000 years during which oaks and pines have been in existence. But leaving all calculations as to the age of trees out of consideration for the present, plants with herbaceous stems, which are annually perishable, whether dicotyledons or monocotyledons, have precisely the same growth, as far *as it goes*, as those which are ligneous and persistent. Any one can speedily convince himself of this. In the case of the stems of dicotyledonous herbaceous annuals, there is visible on the cross section the same concentrical disposition of the matter of the stem into pith, wood, and bark, and the same development of branches in the axilla of the leaves as in the stems of dicotyledonous trees. The whole process of growth is, however, arrested in its first stages, and the stem, with its branches and flowers, dies down to the ground and disappears from the earth's surface on the approach of winter. That the vegetable machinery would continue in motion, and simply stops in consequence of the decreasing heat and light of the sun, is evident from the fact that plants which are annual and herbaceous in temperate climates, become ligneous and perennials in the tropics. Thus the castor-oil plant (*Ricinus communis*), in Pennsylvania, North America, puts forth large peltate-palmate leaves, but is destroyed by the first frosts of autumn. In tropical countries its stem is ligneous and persistent, and it grows into a powerful and lofty tree. It is the same with the Euphorbiaceæ, Labiatæ, Leguminosæ, Boraginaceæ, Hypericaceæ, Rubiaceæ, Verbenaceæ, Polygonaceæ, Compositæ, and a host of other plants which with us die annually, and which in the tropics become trees, elevating themselves majestically into the air. The life of one generation of these plants is therefore now no longer limited to a year, but prolonged for centuries. There is no authority, then, in nature for assigning any definite limits to the number of generations of trees, but, on the contrary, every reasonable presumption that the species of trees now living, and some of which we know to have been living for hundreds and even thousands of years, follow the same laws as herbaceous plants, and that each tree has been preceded by numerous generations;

a view which is in accordance with the usual arrangements and analogies of nature, considering the grander scale of vegetable architecture on which trees are constructed. Thus the antiquity of our flora and its antiquity under existing forms are things exceedingly probable.

The following facts recently brought to light tend to the same conclusion.

Geologists have discovered in very old deposits of turf the bones of mammalia which ceased to exist before the historical epoch. The most remarkable example is that of the stag (*Megaceros hibernicus*), found in the turf-bogs of Ireland and the Isle of Man. In these same turf-bogs the trunks of oaks and pines have been found belonging to species still existing in Europe. Sir Charles Lyell counted upon one of these oaks 800 annual rings. The same facts present themselves throughout the north-west of Europe. They are of importance, as the beds of turf are very ancient, probably anterior to the presence of man in those regions.

Sub-marine forests have been observed at many points of the coast of France and England, recent in a geological point of view, but ancient in other respects, because no tradition or historical document makes any mention of them. The trees consist of oak, birch, hazel-nut, and fir; the same species as those growing in the neighbourhood. We have not space for any more of these facts. Enough has been said to show that, in all probability, existing species are of very great antiquity. We shall now proceed to show that some of them have survived many geological revolutions.

The vegetation of the British Isles is not only European, but it has been ascertained that it shows in certain districts well-marked affinities to that of particular portions of Europe. It is, in fact, a union of four European floras, "three of which are restricted to definite provinces, whilst the fourth, besides exclusively occupying a great part of the area, overspreads and commingles with all the others." These four floras are each characterized by typical plants, indicative of a colonization from a particular continental site. Plate II. is a map of England and Ireland and part of the coast of France. The relative positions of these floras and the area of their distribution are shown in this map by differences in colour. The arrows indicate the direction from whence the plants originally came when they migrated from the Continent. The flora of the British Isles comprises—

I. *The Asturian type.*—This is restricted to the mountainous districts of the west and south-west of Ireland, where twelve or more species of plants are found in great profusion, belonging to the natural orders Saxifragaceæ, Ericaceæ, Lentibulaceæ, and Cruciferæ. This is presumed to be the oldest of our floras. It consists of six species of saxifrage; viz., *Saxifraga* (*umbrosa, elegans, hirsuta, geum, hirta,* and *affinis*); two heaths, *Erica* (*Mackaiana* and *Mediterranea*); the St. Dabeoc's heath (*Menziesia polifolia*); the strawberry tree (*Arbutus unedo*); and a little cruciferous plant called the fringed rock-cress (*Arabis ciliata*). *Saxifraga umbrosa* is well known in the London gardens as London Pride. The nearest point in Europe where these plants are native is the Asturias mountains, in the north of Spain.

II. *The Armorican type,* found in the south-west of England and the north-east of Ireland, where a vegetation occurs not found elsewhere in the British Isles, but which is intimately related to that of the Channel Islands and the neighbouring French coasts of Brittany and Normandy. We have no space for the names of all the plants, but the following may be mentioned as restricted to these parts:—

The White Mountain Rock Rose (*Helianthemum polifolium*); the elegant French tamarisk (*Tamarix Gallica*); a little plant called All-seed (*Polycarpon tetraphyllum*); the Sand Strapwort (*Corrigiola littoralis*); and a species of hare's ear (*Bupleurum aristatum*). These are all Devonshire and Cornwall plants, and do not extend beyond this corner of England. As illustrations of this type found in the south-east of Ireland, we give the Great Sea Stock (*Matthiola sinuata*); the Wild Madder (*Rubia peregrina*); the Cornish Heath (*Erica vagans*); the Gentianella (*Exacum filiforme*), a little plant belonging to the gentian family, from two to six inches in height, with a slender thread-like stalk, which supports a single, terminal, small yellow flower, found in bogs; and the Balm-leaved Figwort (*Scrophularia scorodonia*), a downy plant, about two feet in height, with heart-shaped, opposite, serrate leaves and purplish flowers.

III. *The Scandinavian or Arctic type,* found in the Highlands of Scotland, and more sparingly on the mountains of Cumberland and Wales. These localities show a vegetation analogous and in many respects identical with that of the Arctic regions. For example, on the mountains of Scotland are found the beautiful blue gentian (*Gentiana nivalis*), so well known and justly admired by Alpine tourists; the dwarf birch (*Betula nana*), seldom more than two feet in height, found in the Arctic regions; the Scotch primrose (*Primula Scotica*), discovered by Professor Forbes in Norway, growing in the greatest abundance; the Alpine Veronica (*Veronica alpina*), which displays its lovely corolla on the margin of dissolving snows; the Forget-me-not of the mountain summit (*Myosotis suaveolens*), whose tints far excel those of its name-sake of the brook; the Alpine astragalus (*Astragalus alpinus*), enlivening the turf with its purple clusters, and armed with a fierce array of thorns, as if defying any one to pluck them! But we cannot stop to enumerate any more floral beauties of the Scotch mountains, and must pass on to those of Wales and Cumberland. And here, again, we can only name a few plants, well known it may be to some of our readers, who remember climbing these mountains, and have not forgotten their most impressive scenery. First on our list come two little willows, only two or three inches high, *Salix* (*reticulata* and *herbacea*), well-known polar plants; then we have the pendent orange-cinque-foil (*Potentilla alpestris*), whose blossoms are usually found beautifully blended with the white flowers of the Alpine cerastium (*Cerastium alpinum*). Two saxifrages, *Saxifrago muscoides*, a moss-like looking plant with yellow flowers, and *Saxifraga nivalis* with its obovate, roundish, crenated leaves and white flowers, a hardy mountaineer, which usually selects the loftiest summits for a habitat; the Hairy Stonecrop (*Sedum villosum*); and the Alpine Fleabane (*Erigeron alpinum*), must complete our scanty catalogue of mountain plants; enough, however, for our purpose, as they show their Scandinavian and Arctic character.

IV. *The Germanic Type.* This consists of plants very generally diffused over the British isles, and commingling with all the others,—all our common forest trees, shrubs, and flowers, such as the oak, elm, birch, alder, ash, bramble, wild-rose, yew, holly, poplar, hazel-nut, and the daisy, common heath (or ling), primrose, shepherd's-purse, clover, celandine, coltsfoot, dandelion, groundsel, sweet-scented vernal-grass, and meadow-foxtail, &c. We gladly leave out the botanical names in this instance, for the sake of some of our readers, and because, in the case of such common plants, we can be sufficiently accurate without them.

Professor Forbes makes another group out of the chalk plants common to the south-east of England, and to the opposite coast of France; but these plants must all be referred to the Germanic type, for they are by no means so restricted in their growth as the plants of the Asturian, Armorican, and Arctic types; on the contrary, most of them are to be found in other parts of England where the soil is simply calcareous. "The attachment of these plants to chalk *is an accident*, and not an essential habit of the species."

Now, what is the cause of these peculiarities in the phytogeography of Great Britain and Ireland? First, as to the Asturian flora on the mountains of Ireland. The question is, how did these plants get there? No existing marine currents could have conveyed them from the mountains of Spain to those of Ireland; nor can we suppose the little seeds of the saxifrages and ericas to have been conveyed through the air, as they are not adapted for this mode of diffusion; and, in addition to this, plants with winged seeds, belonging to the natural order *Compositæ*, intermingled with these saxifrages and ericas in Spain, are not present with them in Ireland. Either, therefore, we are driven to adopt the hypothesis of the separate and independent creation of these plants in the two localities, or we must believe that Spain and Ireland were formerly united, and that they migrated before the two countries became separated from each other. Now, is there any geological evidence of this anterior union of Spain and the west of Ireland?

Professor Forbes thinks that there is. He grounds his opinion on the discovery of beds of marine deposits in the mountains of the Taurus, in Turkey, at elevations of from 2,000 to 6,000 feet above the present level of the Mediterranean. From their nature and position it is inferred that, at the end of the Miocene Epoch, the region about the Mediterranean underwent great changes, and the bed of a sea which extended from Greece to the Azores was gradually elevated. A vast continent extended from the Mediterranean to the British Isles, and all that part of the Atlantic which now washes the western shores of Europe was converted into dry land. It was at this time that Ireland was united to Spain, and the Archipelagos of the Canaries, the Azores, and the Madeiras, were probably contiguous in the same manner. The dozen or more plants found on the mountains in the west of Ireland are supposed to be the remains of the flora of this ancient continent, which have survived to the present day. Its existence is indicated by the fact that the plants of the Canaries and the Azores are all one flora, the species being sometimes the same as those in the Asturias and the west of Ireland, but more often identical with the plants of Spain, Sicily, and Syria.

Another argument adduced is the existence of a semi-circular belt of gulf-weed (*Sargassum bacciferum*), ranging between the 15th and 45th degrees of north latitude, which is well known to be a sea-shore plant, and as it is constant in its position, it is supposed to be attached to this ancient coast-line, now submerged, and to indicate its former extent and position.

It was during this era that the plants of the Asturias and those of the Armorican type migrated from Spain to the west of Ireland, and from the French coasts of Brittany and Normandy to the south-east of Ireland and the south-west of

England; and, towards its close, the great continent formed by the upheaval of the Miocene tertiaries, was gradually destroyed. Ireland was separated from Spain, and the disjunction of the south-east of Ireland and south-west of England from the Channel Islands and the adjacent coast of France was effected. The unshaded and most deeply shaded parts of Plate II. enclosed the whole of the area of Ireland and Great Britain then visible.

To this period succeeded the Glacial Epoch. The climate of the northern hemisphere, which had been during the Tertiary Epoch considerably warmer than it is now, became, towards its close, much colder, in consequence of the gradual accumulation of snow and ice at the poles. The ice-formation manifestly began about this time; for, as we go further back into the history of the earth through the Tertiary deposits, we find neither erratic blocks nor any indications of the marks of glaciers; on the contrary, the proofs become more and more apparent that the climate, in these earlier epochs, was much warmer than it is at present. Hence, the appearance of ice at the poles and on the summits of the mountains must be regarded as, comparatively speaking, a recent event in the history of creation, and is contemporaneous with some of the last revolutions to which the earth has been subjected.

During the Glacial Epoch the whole of the northern portion of Europe was covered by the German Ocean, which extended itself from the Alps of Switzerland to the Uralian Mountains of Russia, and covered all that portion of the British Isles and the adjacent coast of France, numbered IV. in Plate II. The tops of the mountains of Scandinavia, Wales, and Scotland—(the area of the two last lightly shaded, and numbered III.), were then low islands. The climate was much colder than it is now, similar to that in the north-east coast of America, in the same latitudes, and presenting very similar phenomena. It was a region of fog, floating icebergs, and boulders, which are able to transport both seeds and plants. With such means of transport existing in abundance around them, Scotland and Wales now received their Arctic flora from Scandinavia.

This Glacial Epoch was again succeeded by another, and at its close Europe presented quite a different appearance. The bed of the glacial sea was elevated. Sweden, Norway, Lapland, and the whole of the northern portion of Russia, and all the parts of England, Ireland, and the adjacent coast of France, numbered IV., were formed. In fact, the land was continuous from the western coast of Ireland across the sites now occupied by the Irish Sea and the German Ocean, to Germany and Russia. Those parts of Scotland, Wales, and Scandinavia formerly low islands in an icy ocean, now underwent elevation, and were uplifted into lofty peaks and mountain chains of unusual grandeur and magnitude. It is not unreasonable to think that even the tops of the mountains of Wales and Scotland, which, ever since their upheaval, have been disintegrating and wearing down, were at this remote era whitened with the snows of a perpetual winter, especially as the neighbouring valleys abound in evidences of former glacial action.

Those sub-arctic plants which formerly grew on the cold low lands in the neighbourhood of the glacial sea now became mountain plants; and therefore, notwithstanding the change of climate, still maintained their footing in the old spots, in consequence of the diminished temperature resulting from their elevation. It was over the great plain thus formed from the west of Ireland to Germany that the plants constituting the great bulk of our flora appear to have migrated. Both plants and animals came across this great Germanic plain, and their descendants still continue to constitute the great body of the fauna and flora of our lowlands. The south-east of England was also at this time united to France, and received from that country its French plants, which, for a series of ages, were thus enabled to extend themselves from France into England, as now from one department of France into another.

The complete separation of Great Britain from Ireland and the Continent, is one of the last changes in the physical geography of the United Kingdom, and comparatively speaking a recent event; although it undoubtedly took place many thousands of years before the appearance of man in Europe.

Certainly, the ideas of Forbes on the origin of our Arctic flora deserve to be regarded now, not as an hypothesis, but as a probability, because they repose on geological data which are becoming every day better established. This glacial sea has everywhere left its traces over the Continent and the British Isles. The plains of Prussia, Poland, and Russia, are strewed with loose detritus and colossal crystalline blocks which have had their parent bed in the mountains of Scandinavia. England and Ireland show similar phenomena. These drift materials known to geologists as diluvial gravel, grey heads, and boulders, formerly adduced as affording physical proof of the Noachian deluge, are now known to have been conveyed to their present sites by ancient glacial action. This process is now going on in nature. Glaciers are always more or less loaded with heaps of gravel and blocks of stone. They are never formed except at the edge of ice-covered lands. When they come down from the mountains into the warmer regions of the valleys, the ice necessarily melts, and the gravel and blocks are left lying on the earth's surface. In the same manner immense blocks of stone detached by frost from the rocks within the Arctic circle are annually floated from the Polar seas southward in the ice which is attached to them, and then dropped when the ice mass melts in a warmer climate. These icebergs are sometimes found floating in masses of incredible size, even half or two-thirds of a mile in length, and sunk in the sea to the depth of 1,000, 1,500, and 2,000 feet.

The base of glaciers is usually thickly set with fragments of rock, pebble, and coarse sand, firmly frozen into the icy mass, which acts as a huge rasp to the underlying rocks, scratching or striating their surfaces in moving over them, or as a smoothing polishing instrument, if the earthy materials in the ice are finely comminuted. This fact is of great importance in a geological point of view, as it has led to the identification of the phenomena of erratic blocks, of smoothed, striated, crushed surfaces, which appear both contiguous to and often *far remote* from existing glaciers. These phenomena are frequently observed in the United Kingdom, and well known to English geologists. The lowlands of Britain and Ireland are thus proved to be portions of the bed of an ancient glacial sea; and geological inquiries have further established the fact, that when the bed of this sea was elevated, the dry land extended over to the north-west of Germany, from which our islands again became divided, by a subsequent disruption resulting in the formation of the Irish Sea, the St. George's Channel, and the German Ocean.

The above facts respecting the English flora, and the attempt to account for them by reference to past changes, open a wide field for philosophic inquiry and research. Every country presents similar phenomena in the distribution of its plants which cannot be explained by any other hypothesis.

A great many plants that are found in the British Isles, for example, are indigenous in the State of Pennsylvania, North America. My reasons for believing this are simply these, I have found them myself under circumstances that would indicate that they are natives. The woods of Pennsylvania are the natural growths of the soil, and in these woods, miles from human habitation, I have found British plants belonging to species without organised contrivance in the seed for effecting their diffusion to localities at a distance from the parent plant. When I find, for example, in the cranberry bogs, in the neighbourhood of Philadelphia, Pennsylvania, both our sundews, *Drosera* (*rotundifolia* and *longifolia*), and our species of bog moss (*Sphagnum acutifolium*), in the salt marshes of Staten Island in the New York Bay, such English plants as glasswort (*Salicornia herbacea*), sea knot-grass (*Polygonum maritimum*) sea-plantain (*Plantago maritima*), and our English sand-reed

(*Ammophila arundinacea*), covering the dunes or hills of blown sand on the American shores of Atlantic City, New Jersey, I cannot help feeling convinced that these plants are the natural growths of the country. And not only the marine, but the fresh-water plants of Pennsylvania are in numerous instances the same as those found in the British Isles. Of twelve species of pond weed (*Potamogeton*), eight are indigenous to Britain. The genera of the order *Naiadaceæ* are all British plants. Every stagnant pool is covered with duckmeat (*Lemna minor*), and the water star-grass (*Callitriche verna*) floats there, as here, its beautiful green stars on the surface of running streams. In fact, the lower we descend in nature, the more the flora of both countries approximates. The mosses and lichens of Pennsylvania, with but few exceptions, are the same as those of Great Britain.

How are these facts to be accounted for? Here we have the same plants growing in similar localities thousands of miles apart from each other. If I may venture an opinion as to the causes which have led to this similarity between the vegetation of Pennsylvania and that of the British Isles, I would say it is because the conditions that prevail on the sea-coasts, and in the fresh-water marshes and streams of both countries, are very similar. The same ocean washes their shores, and the difference of latitude is only about 11½° or 10°. The latitude of Philadelphia is 39° 57′ N., New York 40° 43′ N., and that of London 51° 31′ N. It is true that the summers of the State of Pennsylvania are much hotter, and the winters much colder, than those of England. Yet, in both countries on the sea coast, the great body of salt water tends to produce there a greater uniformity of temperature through the year than prevails inland. Nevertheless, it is hard to believe that mosses, lichens, and ferns, originated without spores, or that sundews, sea-plantains, glassworts, and sand-reeds, were created in these localities without seed. There is nothing in nature to justify such an hypothesis. It is undeniable also from these phyto-geographical facts, that where similar conditions prevail, the same plants are found. But if the conditions have survived the geological revolutions which have dissevered the species, this accounts for their existence and disjunction, without resorting to an assumption (which the progress of science is rendering every day more improbable) that plants were created directly out of inorganic matter, independently of spores and seeds. The same species would still survive, though mountains should rise and oceans roll between them, and continue unchanged through all the mutations of physical nature and the lapse of ages.

METAMORPHISM.

BY PROFESSOR D. T. ANSTED, M.A., F.R.S., ETC.

IN all the natural history sciences there occur series of changes, systematic, governed by definite laws, growing out of a kind of development, and leading by successive steps to entire modifications, more or less important, in the general economy of nature. Thus among insects we have the change from the grub to the chrysalis, and from that to the butterfly or beetle. Among plants, the conversion of leaves into petals, or petals into stamens, may be mentioned as examples. Among minerals, the transition from such a rock as vesicular lava, full of air blebs, as seen in volcanic countries, to the basalt, whose cavities are all filled with crystalline minerals, derived from what was once lava, is a similar instance.

The gradual conversion of one combination of the simple elementary substances into another, whether influenced by life or not, is a great fact in nature. It is called growth or development, when there is life, but in the mineral world there is no such familiar expression for an equally familiar fact. The fact of perpetual change is, however, readily admitted, on a moment's consideration, as belonging to all nature. It is a fact, pregnant with the most important consequences, and when the idea of it is carried out logically, it leads us to very startling conclusions.

In geology, and indeed sometimes in botany and zoology, this power and habit of conversion is technically called *metamorphosis* (μετὰ, change; μορφη, shape). It is a term convenient to us when we wish to speak of change of the form without essential change of the ingredients of a rock. Thus when we take up a specimen of chalk, or of compact limestone, capable of being polished as a marble, and on looking carefully and microscopically into its structure, find it made up of shells and shelly mud, just as we know the mud at the bottom of the sea to be accumulating in existing oceans, the geologist describes as a *metamorphosis* the change of form that has taken place to convert marine mud into compact limestone. In this case the mineral consists of minute particles mixed irregularly with larger fragments of shells of various kinds. The mud has little cohesion. The marble, however, is changed, and partially crystallised; it has a peculiar and definite texture; it is extremely compact, and of uniform colour and hardness. It is converted into a substance apparently distinct and with different properties. It is *metamorphosed.*

So also with regard to clay and slate. The latter is precisely similar to the former in composition, but the difference between them is in some respects enormous. For all practical purposes they are as different as limestone and quartz, but still the slate is nothing more than a metamorphosed clay.

There is nothing mysterious in metamorphosis; it is a change wrought by time and circumstance, and in zoology it represents a development of inorganic matter corresponding to well-known developments of organic matter. But although not miraculous, it is surrounded with interest and involves many difficulties. The analogy with the phenomena of life is not to be assumed without some knowledge of the circumstances of the case.

Every one who has even a superficial knowledge of the main outlines of geology is aware of the existence of certain rocks called slates and schists, which are so different from the common stones and rocks deposited from water, that they seem at first to have no relation with them. In all geological books these are called metamorphic rocks, and they well deserve the name. These are but examples of a particular stage of metamorphic action. The changes leading to the formation of slates and marbles require to be followed out from the commencement, if we would understand what they are, and what they lead to.

It is not easy to acquire a knowledge of the mode in which Nature acts on a large scale in the accumulation of the deposits that will ultimately appear at the earth's surface, as the limestones, sandstones, and clays, of some yet unborn continent. That all such infant and growing land is now under water; that a large part—almost the whole—is of necessity buried not only by water, but by a constantly thickening crust of similar material, each layer more recent than the rest, and therefore, still less affected by any change, there cannot be a doubt. Setting aside all theory,—all attempt at investigating doubtful problems and questionable phenomena,—who can consider for a moment the state of things on the earth without coming to this conclusion? The two ends of the great natural scale are manifest enough. We trace the recently heaped mud and stones at the bottom of shallow water, and we can examine the rocks from which they have been removed. The derivation of river detritus and sea mud from the adjacent soil, and from animals living on land or in water, is not difficult to make out. The mud at the mouth of the Ganges, the Mississippi, the Nile, and the Rhine, may even be measured and weighed; and it is certain that what is gained by the water is lost by the land,—at any rate, to a large extent,—but there our daily experience ends. We do not see what becomes of this mud; we do not know and cannot trace with our eyes the changes that must take place before it can again assume the form of the rock from which we know it to be derived. We can easily reduce rock to mud, but not easily convert mud into rock. This sort of knowledge we must obtain, if at all, by applying what we know concerning the general laws and methods of nature. We must study mud and detritus under various forms, and study also rocks and minerals under all the different conditions that are available. It is thus, and thus only, that we can hope to obtain a glimpse of the real history of strata.

Now the first thing to be noticed is the total absence of any repose in the present state of things on the earth. Owing to the three forms of matter—solid, liquid, and gaseous,—earth, water, and air,—and the incessant change of temperature characteristic of the surface of the earth, there cannot possibly elapse one moment of time without motion in every direction; and if motion, then friction, wearing and removal of surfaces in contact, and thus more heat and more motion in an endless circle. And what is going on at the contact of earth, air, and water, where we live and breathe, is not in any way confined to these limits. Earth, air, and water are in contact and in motion as far below, and out of our sight, as they are in the upper regions of the atmosphere, where the clouds are always chasing one another, and where rush the meteors so incessantly presenting themselves, and so often crossing the earth's path. It is not only from the rumbling of the earthquake, or its fierce and vehement eruptions of fire and ashes from the volcano, that we know this. Wherever the waters pour forth their life-giving streams, whether from natural or artificial sources; wherever the mine gives forth its metalliferous wealth; wherever, in a word, the intelligence of man can penetrate and lay bare the doings of nature, there we know there is constant motion and constant change. The electricity that we conduct along the wire to enable us to communicate instantaneously between distant points, is but an infinitesimal part of the current that circulates from pole to pole, beneath the surface of the soil. The effect that we produce so readily by a few dissimilar minerals in contact with some simple acid, cannot fail to be produced with ten thousand times greater result within the earth, where are all the materials at hand. What are the strata and the veins, and the vein contents, but a vast collection of galvanic batteries, whose supply of metal and acid, and water never fails, and which keep in constant action the chemical forces employed in Nature's great laboratory?

We know the mode in which the ordinary rocks, under atmospheric influences and without much pressure, work up into stones, and incoherent mud, and sand. Would we see the effect of pressure upon these—pressure alone without chemical action of any kind,—we have only to use the methods now in the hands of the navigator, for lifting into the light of day, and away from the influence of the sea, the corresponding mud in deep water. The mud lifted from 2,000 fathoms in the Atlantic by Dr. Wallich is described as "of a plastic consistence somewhat akin to that of putty, but the adhesiveness of the particles infinitely stronger." The same material is described by Professor Huxley, who examined specimens after being in bottles for some time, as an excessively fine light brown muddy sediment, closely resembling fine chalk when dried. There can hardly be a doubt that this mud, which under pressure alone is so tenacious as soon as formed, would soon become almost solid when covered up with a considerable thickness of the same material. It would thus become a rock closely resembling chalk.

If we take up a small hand specimen of any rock, and examine it with a view to its origin, we shall at once recognise the fact that some essential change has taken place since it existed as mud or sand, as part of a river bed or sea bottom. That it once so existed we may often find proof in the remains of animals or vegetables, distributed through the mass, and even making up a definite proportion of the whole. The microscope will often greatly assist the student in making this out. The minute examination of the various particles will often show that they have been rubbed and water-worn, and then cemented together by some foreign substance, such as carbonate of lime, brought in by water. Some are perhaps the cases of those little chambered shells that abound in certain parts of the ocean; or are parts of shells, corals, or other hard stony cases of marine animals, ground down by rolling upon each other; or are quartz sand, broken up in a similar manner; or they are mere particles of clay. All these are proofs of what is called aqueous origin, but no accumulation of the same kind seems within our experience as happening now.

Extending our investigation to a series of strata as shown in a railway cutting or a quarry, we advance another step. The evidence of original formation by water is yet more clear, but the beds are often still more unlike what would now be seen. The mud brought down by a river, or produced by the beating of the waves on a shore, would, if not heaped without order, be arranged in order of relative weight of the particles.

The quarry and the cutting tell a different tale. In a cutting of the lias, such as are seen in Leicestershire, or at Whitby, or at Lyme Regis, or elsewhere, the greater part is clay, but there are bands of different material. The original clay mud was mixed, no doubt, with carbonate of lime mud, but now belts of nearly pure carbonate of lime are seen at intervals. These are generally collected round certain remains of animals, generally fishes or marine reptiles. The mud is not altered in other ways, but parts once mixed with the rest have settled, as it were, into particular strata. And something of this kind is seen in every cutting, not only of clay, but of limestone and sandstone. There is much more order and system than in a recent accumulation, and the order and system are chemical rather than mechanical.

The amount of change observable in all these cases has certainly been brought about after the original deposit of the strata, without any mechanical or external action, and without much heat having been brought to bear upon them. It is a change, however, that has often entirely re-arranged the particles of the mass, and while sometimes so small as not to have altered the most delicate details of a fragile shell, has entirely re-modelled the composition and arrangements of thousands of tons of rock in a comparatively small area.

Coincident with these remarkable changes in the accumulated masses that make up a comparatively simple rock must be named the formation of cracks and fissures, no doubt the result of the contraction of the whole when water was parted with in the act of drying. And that this water may be parted with to some extent, even while the whole is covered with water, there is no doubt. Solidification is itself a definite change, and a partial metamorphosis.

The filling up of the cracks in rocks is a process so manifestly subsequent to the solidification of the mass, that the statement of the fact is sufficient. The fissures are often closed with the same mineral as the rock, but generally in a crystalline state, the crystals shooting out from the sides towards the middle of the cleft, and there meeting so as to leave no space. More frequently there are spaces left, and these are occupied by other crystals, identical in composition with one or more of the accidental contents, or impurities of the rock. Thus in limestone the cracks are filled for the most part with calc spar, but there are often beautiful crystals of quartz shot so as to fill up spaces. Iron pyrites, fluor spar, ores of lead and zinc, and other foreign substances, and sometimes native gold, are occasionally entangled among the calc spar in a singular manner.

The gradual transition of chalk into white limestone, and of that into marble, is a phenomenon sufficiently well known to be quoted as an example of gradual change. The passage of sand into sandstone, and of that into a rock so compact, hard, and crystalline, as to become quarzite, is equally familiar to geologists. Clays, in like manner, pass into shales very gradually. Some shales put on the character of slate, and slates are but modified shales. All these are examples of repeated metamorphism, first producing and then modifying the simplest, most familiar, and most abundant rocks.

In truth, no one can examine a stone from a quarry, a clod from the field, or a specimen from a mine, without being made aware that he sees a changed substance,—changed, perhaps, from something common and simple enough,—changed, it may be, into something equally simple and equally common,—but always a new thing, not the rock deposited, but the rock derived. And this is one of the great lessons to be learned from geological pursuits. The earth is not a planet once formed after a certain fashion, and ever since remaining in the same state. The minerals beneath our feet are just as much in perpetual growth and development as the animals and the plants on the surface. They live their life and suffer their death. Rocks are developed, not merely accumulated; and this is the case with every variety of limestone, sandstone, and clay, as well as the slates and schists usually described as metamorphic.

Metamorphism, then, is not, in this sense, a marvellous and mysterious principle, interfering with the natural order of things, and producing unknown rocks in an unknown manner. It is a term which may and must be applied, if it be applied at all, to every rock of the earth's crust, aqueous as well as igneous. It is not too much to say that no such thing exists in nature as an unchanged accumulation of mineral substances. The nearest approach would be a heap of quartz sand; but even where nothing but quartz sand is present there are generally portions harder than the rest, portions where water has bubbled through and carried with it foreign material of various kinds, acting as a cement, and leaving behind ample proof of its passage.

But no doubt there are degrees of metamorphism, and we have as yet considered only the most simple. The passage of rocks, once clay, into the state of roofing slate, and the passage of other rocks into such minerals as gneiss and mica-schist, are extensions of the metamorphic actions just described. They involve a more complete carrying out of the principle of change, for they are removed yet further from the normal condition of accumulated fragments rolled and worn by the action of water.

Slate is a very interesting example of the state to which a rock may be brought by those changes that act in the interior of the earth, on a grand scale, without, of necessity, destroying all traces of the original construction of the material acted on. In a slate quarry it would be easy to pick up specimens showing perfect cleavage, or, in other words, splitting into films, as thin as paper, in a direction altogether different from that of the original strata. In the same hand-specimen, the original stratification might be recognised by fossil shells, and by lines very clearly marked, but in which there is no tendency to split. Still, in the same specimen, there may be a tendency to break up into definite mathematical solids, almost always exhibiting the same set of angles. In the intervals between these latter planes (technically called *joints*) crystals of silica and pyrites will be found. Little cubical crystals of pyrites will also be disseminated through the slate, quite independent of cleavage joints or bedding. When we consider that the original rock in this case was certainly clayey mud, that any impurities have been crystallized out, but that the chemical composition and mechanical arrangement are hardly altered, and that there is no real resemblance to crystallisation in the mere facility of splitting, it is clear that the metamorphism is of a high order. Pressure enormous and long continued, probably combined with an equable temperature for a long time, is the *vera causa* to which we must revert to account for these phenomena. But pressure will not fill the crevices, nor separate out the iron and silica, nor deposit these minerals afterwards. Pressure with a certain amount of chemical action must here have combined in the recesses of the earth, and the change is one that must have required time as well as force.

The fact that cleavage is producible by pressure alone, even without any exercise of chemical action, is undeniable. It was illustrated by Mr. Sorby, in 1856, in reference not only to slates, but limestones, consisting of fully 50 per cent. of particles of shell and other organic substances, the rest of the rock being crystalline. In fissile rocks of this kind the microscope shows that the particles of organic origin, irregularly distributed where cleavage does not exist, are pulled out, as it were, and lie parallel to the direction of the cleavage planes where cleavage has supervened, and that in these cases cleavage is quite independent of stratification. Even the shape of the cells in encrinite joints is elongated by the cleavage, and the very crystals themselves are pulled out in a similar manner. It is well known that the shells in roofing slate, when they have been retained, are distorted in a similar way. Thus a kind of metamorphosis is produced by mechanical action only.

It is not necessary to pause here to explain that the varieties of mica-schist, some of which show a ripple mark, while all exhibit more or less of mechanical origin, have originated in deposits made in water. Even gneiss, though often different from schists and resembling granite, and sometimes passing into that rock, must be referred to the same agency.

But when we come to granite, it may be supposed that the case is different. Including under that general name all the varieties of rock in which crystals of quartz, of potash or soda felspar, of white and black mica, of hornblende, and of other minerals, are embedded in a paste of quartz or felspar, and looking at its position (generally underlying or thrust up through other rocks), we seem to have reached the original rock, and first appearances would suggest that this must have been in a state of igneous fusion. But more minute and careful observation satisfies the geologist that granite, like other more familiar rocks, may be but a modification of the rest; that as it is sometimes inter-stratified with slates and schists, it must, in all probability, have a similar origin; and that all the extreme peculiarities of structure it presents may be only a still further carrying out of the great principle of metamorphism, so that granite is a metamorphosed rock in the strictest sense of the term.

On examining the condition of the minerals of which granite is composed, it is impossible not to arrive at a similar conclusion. It consists, to a large extent, of quartz. Now, quartz may result either from igneous fusion or aqueous solution. In the former case, however, as determined by experiment, its specific gravity is 2·2 only, while in the latter it is 2·6. The specific gravity of quartz in granite is 2·6, as is well known. Again, a particular kind of mica, containing no less than 4 per cent. of water, forms an important part of some varieties of granite. Certain minerals, which swell and alter their properties on exposure to a much lower heat than is needed to melt granite, abound in some varieties of the rock. And, lastly, there are several distinct minerals forming granite which would cool in a certain order if they had all been fused together, but the order in which they have been formed as crystals does not agree with this sequence.

There are other reasons why it is impossible that granite can have existed in a fused state. The quartz of which it is made up has certainly crystallized from an aqueous solution, for it not only contains water in its composition, but it is often full of minute cavities filled with water. These cavities are, no doubt, small, but they are marvellously numerous. In some specimens of quartz they are not $\frac{1}{1000}$ of an inch apart. They occupy five per cent. of the volume of the mineral, and as much as one-half per cent. of the weight of the quartz is got rid of when this fluid is evaporated off. Thus, in each cubic foot of such quartz there is more than half a pint of water. The water is not generally pure, but holds in solution common salt, or the sulphates of potash, soda, and lime. It should be added that no two granites are alike in the number or magnitude, nor in the nature of the fluid contents in the cavities of their quartzy portions.

In contradistinction to this condition of granite, it has been found that rocks melted and cooled near the earth's surface away from the presence of water, or without pressure (such as lava), have cavities; but that cavities in such rocks are filled with gas and not fluid. The water would seem to be caught up in the act of crystallization just as now the same result is produced when we crystallize salt, and thus the temperature at which the solidification took place may be estimated.

Granite rock, however, is often seen not only in mountain masses, but occupying narrow and tortuous cracks in various rocks, and even injected, as it were, into other varieties of granite. Examples of this kind have been quoted again and again in proof of the identity of granite with lava, or at least of a common origin to the two. It need hardly be said that these appearances, however striking, must not be explained by any hypothesis that does not meet all known facts, and among them the presence of water in the cavities of the quartz. It must be admitted that whatever be the case with lava and with rocks containing no water cavities, the rocks that do contain water must have crystallized in contact with water. By testing the temperature at which the water of the cavities becomes steam, we learn the limits of temperature during the formation of the rock. A possible pressure of miles of water and rock and a high equable temperature must not be omitted in estimating the circumstances of formation of such rocks.

But whatever may have been its origin, granite has often been altered and metamorphosed since its original formation. Its crevices and veins have not only been filled with crystals, but these in many cases have been entirely changed more than once, the new mineral sometimes assuming the form of some more ancient crystal, just as the hermit crab adapts itself to the old shell of a whelk.

There are then no rocks that are not metamorphosed. All are changed, and in all the process of change is gradual, but incessant. The chalky mud has become converted by slow degrees into soft chalk or limestone. This, at one time friable and stratified, has become harder and more compact, and has gradually lost its fossils and its stratified character. It has changed into an imperfect marble, and sometimes into a perfect granular marble fit for statuary purposes. Its cracks and cavities have been filled with calc spar. So the loose sands have been cemented and compacted into sandstone, and that again into quartz. The clays have become shales and slates. All together have become granite. But in what way has this been done? What is the great agent of metamorphorsis in the earth? We have yet to consider this question.

A very superficial glance at the economy of nature in carrying on the daily routine of operations on our globe will satisfy any one that the circulation of water, from the ocean and through the atmosphere, upon and beneath the surface of the land, and so back again to the sea, is in the highest degree important. And the more the phenomena of water are studied the more important do they appear. Not only does the water in its circulation modify the main features of the surface, but a large part enters beneath the surface and emerges only after having travelled far and penetrated deep. In its journey through strata and among the deep recesses of the earth it performs work that most of us dream but little of. Distilled from the ocean as warm vapour, the atmosphere becomes saturated and either as invisible vapour or cloud the water is drifted along for hundreds of miles with little change. But no sooner is it converted into rain and passes through the lower strata of the atmosphere to the earth, than it absorbs carbonic acid and a few other ingredients. With these powerful but simple implements it soon works wonders. It dissolves a way for itself; where it cannot run through porous rocks back to the surface, it makes its way downwards, now removing from, now adding to the strata or the fissures through which it passes. As it goes down it acquires the temperature of the earth's interior —a temperature increasing gradually with the depth to the greatest depths hitherto reached, but nowhere becoming excessive. The warmer water is with respect to some minerals a stronger, with respect to others a weaker, solvent. The water makes its way silently, but as it goes it everywhere promotes change. Some rocks it cements, others it loosens; in some the minerals and fossils are altered in material, but not in form; while in others the form is altogether obliterated, but the material remains. Down to the greatest depths it is conveyed, not rapidly perhaps, but with a certain inevitable inexorable fate. Up from these depths it re-ascends, governed by the same fate. While some water sinks, an almost equal quantity is evaporated again, and the water from below is constantly sucked up to replace that which is taken from the surface. This great law of nature is as certain and inevitable as the circulation of the blood in a living human being. It represents the life of the world.

And this it is that promotes metamorphism. No sooner has the mud of the sea-bottom become formed than it begins to be covered. When covered it begins to consolidate and parts with some of its excess of moisture. In this state it may long remain, but ultimately it gets covered up with coat after coat of similar or different material, and by some of those depressions that constantly affect large portions of the earth's crust it sinks down and acquires an equable temperature belonging to its depth. Thus placed it is subjected to the influence of such polar forces as act within the earth's surface. It is also subject to enormous pressure greatly increased in the event of an upheaval. During all this time water acts. It helps the half-formed mass to become a definite solid; it penetrates every pore, and crystallizes the yet shapeless atoms of the ancient mud; it fills up all the crevices; it takes away here and replaces there; it separates out small proportions of foreign bodies, collecting them into one place; it converts the shapeless mass into strata; it forms bands that are among the strata, but independent of them; it even helps the separation of metals, and places them in a certain order in the vacant spaces.

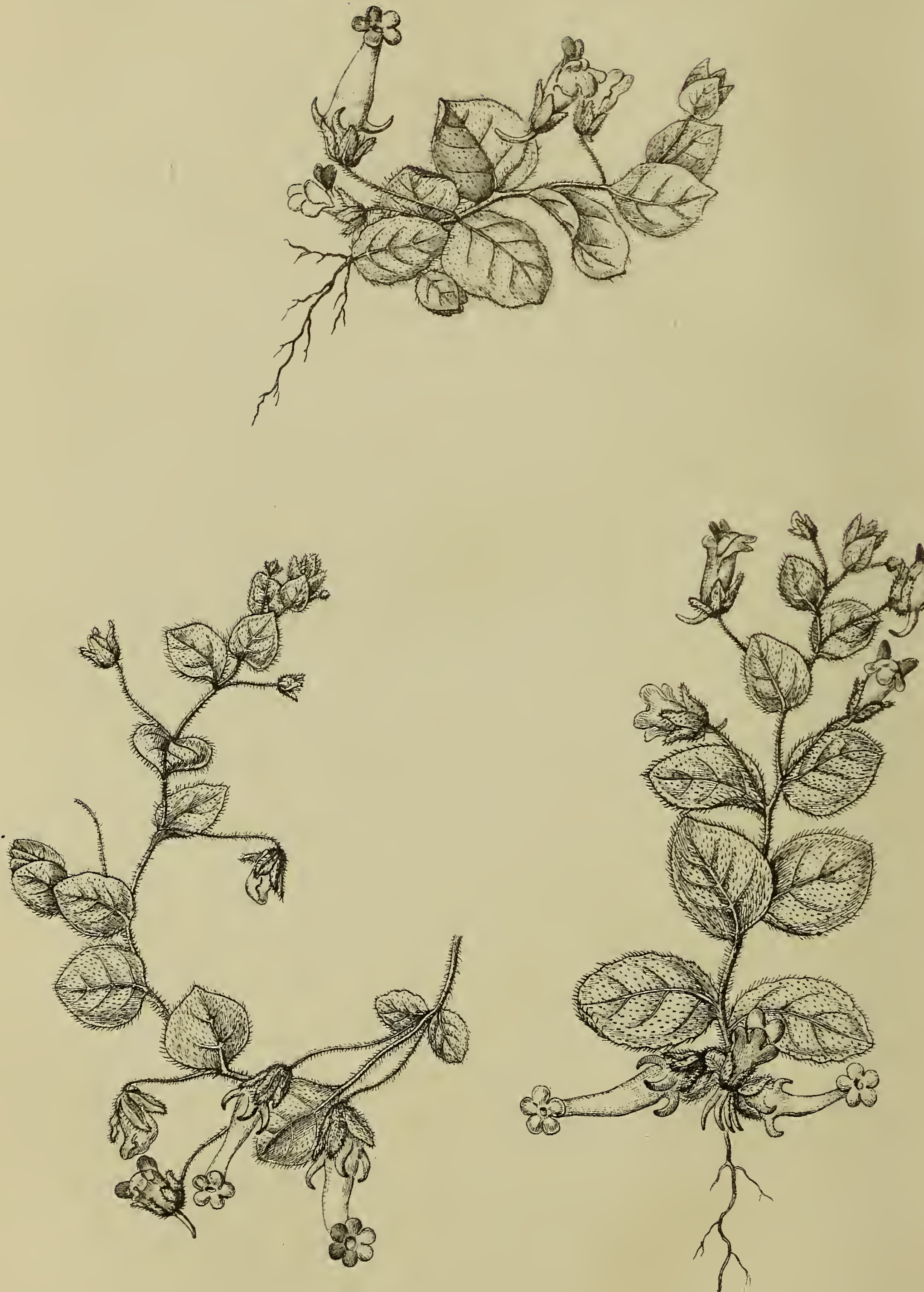
Far from being obstructed by the compactness produced by superincumbent weight, water acts with more vigour as the pressure is greater. Where the depth is very great and the temperature high, as at a depth equivalent to the height of Mont Blanc and a temperature of 680° Fahr., the conditions would be favourable for the formation of granite. At smaller depths and lower temperature all intervening modifications and metamorphoses may be produced.

Such is metamorphism in geology—a change in rocks induced by the action of such temperature, such pressure, and such a percolation of water as we believe to exist within a moderate distance from the earth's surface; a change not involving destruction, but on the other hand essentially formative. It is a change neither violent nor convulsive, but normal and regular; imposed originally on matter, adapted to the conditions under which the earth was originally formed, carried out continually and incessantly, formerly as now, and now as formerly. This is the idea of metamorphism that commends itself to those who would regard geology as a true history of the earth, and who would if possible explain phenomena by such a causation as is consistent with their knowledge and experience.

The foregoing are a few simple facts tending to illustrate the position that metamorphosis is a great fact in nature; that it is the rule, and not the exception; that it is constantly going on; and that its natural result is the production of such a world as that in which we live.

BRITISH MUSEUM
NATURAL HISTORY

Plate III.



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Abnormal form of Linaria Spuria.

MORPHOLOGICAL PECULIARITIES OF LINARIA SPURIA.

BY E. S. MAGRATH.

THE anomalous forms which plants, or portions of them, sometimes assume, are a subject of exceeding interest to most students of botanical physiology. It is difficult, if not impossible, in very many cases to trace these abnormal developments to any definite cause; and yet an attentive examination of them may sometimes throw much light on investigations into the morphological structure of plants.

Having lately met with a case which illustrates, in a very curious manner, the tendency of irregular flowers to become regular, it has occurred to me that a brief notice of it might not be wholly without interest for the readers of the POPULAR SCIENCE REVIEW.

While on a botanical ramble in the neighbourhood of Henley-on-Thames, early in September, I came upon a sandy corn-field which Nature seemed to have intended as a congenial habitat for most of the species of Linaria.

The showy *L. communis* displayed its not ungraceful flowers on the border of the field, while the rare *L. repens* peeped from the hedge-row, into which it had crept from the neighbouring pasture, where its pale blue petals, striped with violet, rose everywhere above the grass. In the cultivated ground from which the crop had just been removed, the erect, quaint-looking *L. minor*, and the graceful *L. elatine* with its hastate leaves and trailing stems, were everywhere abundant. Passing by these with the recognition due to familiar friends, I proceeded to search for specimens of *L. spuria*, which I had reason to believe might be met with in this favourite abode of the genus. Nor was I disappointed, as it grew plentifully among the stubble. The first plant I came upon was in seed. In taking it up, I observed a singularly curious-looking blossom lying on the ground near the flower which I had just gathered. It consisted of a regular monopetalous salver-shaped corolla, very much resembling that of *Primula veris*, except that the tube was rather longer, less cylindrical, and more contracted towards the limb. The limb itself, which was much smaller than that of the cowslip, consisted of five regular lobes, marked on the tips with a rich velvety brown. After a careful examination of the spot for the plant from which the blossom had fallen, I gave up the search, never imagining for a moment that it had perhaps dropped from one of the swollen capsules of the plant which I had then in my hand. However, proceeding with my search in another part of the field, I soon discovered one of my little friends *in situ*, peeping out between some broken flints, and afterwards another and another, until at length they occurred so frequently, that, but for the *peculiar position* of the anomalous flowers, one might have fancied a regular corolla to be the normal condition of a new variety of *Linaria*. It became evident, however, after an examination of numerous specimens, that these monstrosities were in a great degree confined to the lower part of the stem of the plant. Instead of a single subulate spur, as in the ordinary form, the abnormal corolla was furnished with no less than five, which becoming broader and erecto-patent, presented the appearance of a regular calyx, while the calycine leaves—larger and more lax than usual—bore a strong resemblance to those of the stem. In many specimens the tube of the corolla was marked a little above the spurs, by an inconspicuous fleshy ring, somewhat similar to the indistinct articulations observable on the bodies of some of the annelids.

In endeavouring to trace the cause of this singular morphological change, a great number of specimens were minutely examined, both as they grew, and afterwards when gathered and prepared for preservation. It may here be observed, that the petals retain their form and colour remarkably well when dried. The rough etchings given are made from some of the smaller specimens preserved for the herbarium.

The most natural hypothesis seemed to be that the spurs of those flowers which grew close to the ground (sometimes between broken flints), having been arrested in their growth downwards, divided, and produced the singular change of structure which has been described above.

That the variation in the form of the corolla was influenced, if not altogether caused, by the division of the spur, was curiously and strikingly exemplified. In many instances the flowers examined were furnished with two, three, four, or five spurs respectively. When provided with only two, the corolla departed but slightly from the normal type. It remained still distinctly two-lipped; the upper lip, however, was reduced to half its usual size, and consisted of one, instead of two lobes. The lower, on the contrary, became much broader and flatter, having gained the lobe which the other had lost. In this instance the palate still remained closed, as in the ordinary form of the flower.

When the number of spurs increased to three, the form of the lips remained much the same as in the last case, except that the lower lip, instead of being horizontal and almost plane, became erecto-patent and slightly concave, thus occasioning a widening of the palate.

When the spurs became four in number, the corolla in some instances presented an appearance differing but slightly from that with three; while in others it closely resembled that with five spurs, as shown at B in the drawing given above.

It is worthy of notice, that when the spurs grew downwards, and in the same plane, or rather curve, as they frequently did when limited to four, there was little approach to regularity in the form of the corolla, as may be seen at A. It was only when they became curved *upwards*, or erecto-patent, and disposed at equal intervals round the tube, as in figure B, that the salver-shape was assumed.

These successive and well-defined morphological changes, observed in a great number of specimens, seemed highly curious and suggestive, in connection with the study of vegetable physiology.

The comparative rarity of *L. spuria* under circumstances favourable to the development of these singular forms, may account for their not having been (so far as I am aware) hitherto noticed.

As *L. communis* has been frequently known to produce a monstrosity with five spurs, and imperfect stamens (the Peloria var. in Eng. Bot.), I examined minutely the stamens of the abnormal corolla of *L. spuria*, and generally found them as perfect as those in flowers of the usual form. In one instance, when the corolla dropped from the ripening capsule, the seed did not appear in any respect different from that contained in the other capsules of the same plant. These seeds have been carefully preserved, but, it is to be feared, not in a state sufficiently matured to afford any decisive proof of organic imperfection, should they fail to germinate.

Perhaps some of my readers may be able to supply additional and valuable observations, which may serve to elucidate this interesting phenomenon.

EXPLANATION OF PLATE III.

A.—Corolla with four spurs growing downwards, and in the same curve.

B.—Same, with the spurs curving upwards, and placed at equal intervals round the base of the tube.

C. C. C.—Corollas with five spurs and salver-shaped limb.

D.—Limb of Corolla with six lobes.

THE METRIC SYSTEM.

BY JAMES SPEAR, ESQ.

"Le nouveau système des poids et mesures est une des choses les plus utiles à l'humanité."—LAPLACE.

"TO estimate each species of magnitudes, a fixed unity or measure is necessary which shall serve for term of comparison. Formerly in France, as in other countries, there reigned the greatest confusion in all measures; each province had its own particular measures, and the result was extremely embarrassing to trade and commerce. The kings of France attempted, but in vain, to establish uniformity, and to bring back all the measures to those of Paris. At length, on the 8th of May, 1790, the Constituent Assembly issued a decree, whereby it recognized the necessity of a complete reform. A commission, nominated by the Academy, and composed of Borda, Lagrange, Laplace, Monge, and Condorcet, was charged to prepare a general system of measures. The new system was adopted by the Convention, sanctioned later by the Legislative Corps, and declared obligatory from the 2nd of November, 1801. It reigns this day throughout the whole extent of France, and is called the *Metric* system, because all the unities of measurement derive from the unity of length, that is, from the *Mètre*."—*Briot's Arithm. Transla.*, chap. vi.

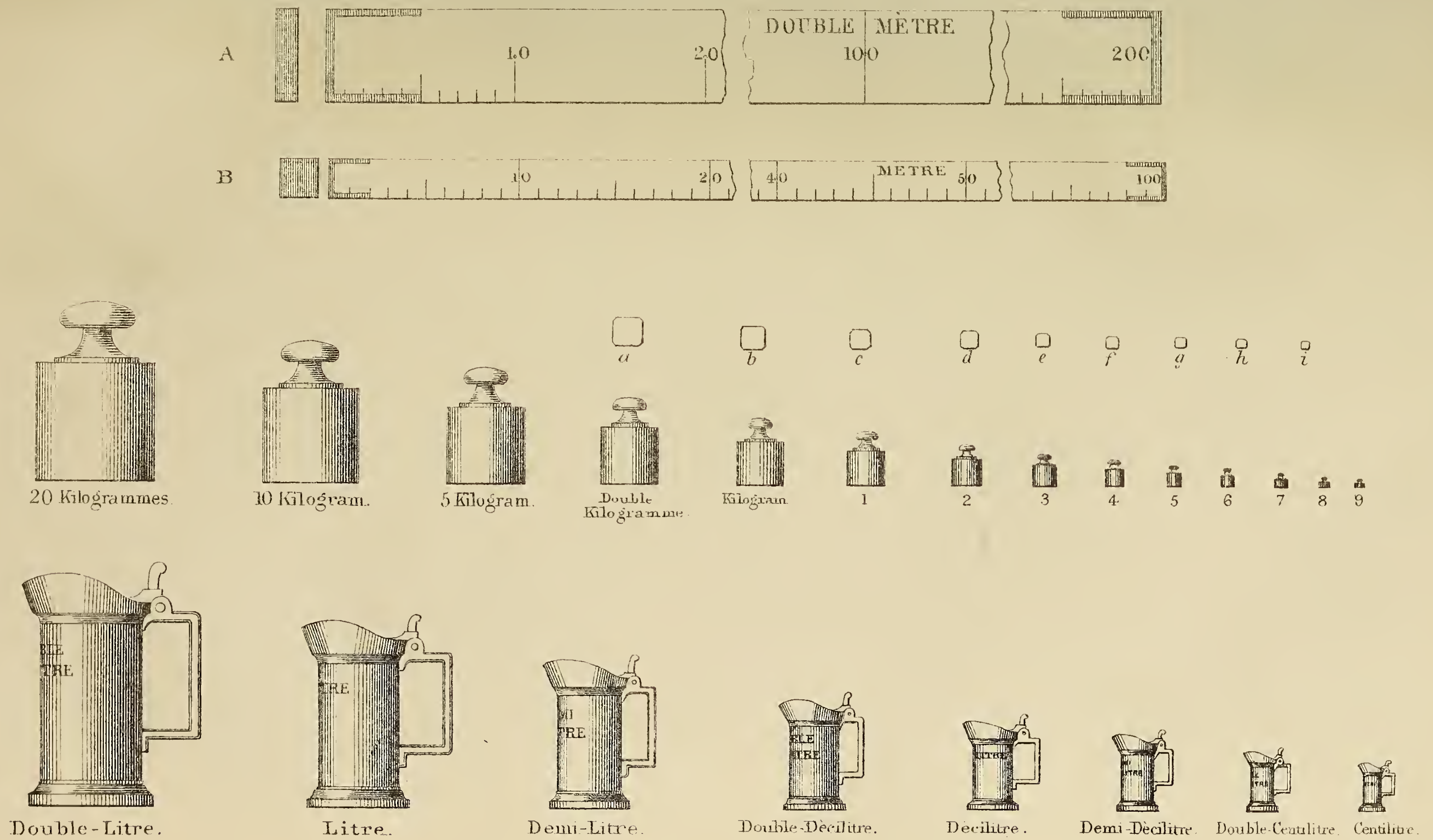
The law above referred to was destined, however, to remain for a lengthened period in abeyance, or with only partial fulfilment; nay, even to encounter the hostility of the Revolutionary authority itself and of successive Governments, until that of Louis Philippe took up the matter with earnestness and promptitude, and after a sharp struggle succeeded in passing a law which should abolish all the old and complicated machinery of weights and measures still existing in the different departments of France, and reinstate the new system called *"Métrique"* in all its fulness and simplicity. This law, now in vigour, came into operation January 1st, 1840.

The confusion and disorder which formerly prevailed in France could scarcely exceed that which is prevalent in England at the present day from the same cause. Nor have successive Acts of Parliaments been able to arrest the evil, nor to introduce anything like order and regularity in our multifarious scales of weights and measures. Local customs, combined with ignorance and prejudice, are everywhere prevalent, to the great detriment of our home and foreign trade. Our standards are many and arbitrary, and have no connexion one with another. But of what use can standards be where there is no power to enforce them; where stability is unknown, and nothing but abuses and caprice seem to govern our markets?

In linear measure our scales are discordant, nor does the same name indicate a fixed value. Our miles, ells, and fathoms are all variable, according to circumstances; and in different trades there are special measures of length particular to each, but unknown to the rest of the world. Similar discrepancy exists in the measurement of surface, with much enhanced difficulty and perplexity; and we have, besides the statute acre, about six or seven others of different dimensions. But our measures of capacity and weight are positively intolerable, and fluctuate to an incredible degree, with an infinity of names and designations, chiefly of the most unreliable and even suspicious kind. We have at least eleven different scales of weight. A stone may mean any one of ten different quantities; and, for climax of absurdity, the hundred-weight in some localities means 112 and in others 120 pounds. For measures of capacity we have not fewer than twenty different bushels; the latter term is sometimes used to designate a weight, but in either acceptation a most variable quantity. The same may be said of quarters and loads, which have no fixed meaning, but vary from town to town. And as for pipes and hogsheads, who can tell their capacity? It would be idle to pursue the tale any further, and we revert with sensible relief to our proper subject.

It ought to be observed, that England had been invited by France to co-operate in the work of reform, for it was the desire of the latter to frame a system of weights and measures which should be applicable to the requirements not only of the two countries themselves, but of all civilised nations. It was proposed that an equal number of commissioners, chosen from the French Academy and from the Royal Society of England, should meet at some convenient parallel of latitude, between the equator and the north pole, in order to ascertain the exact length of the second's pendulum, for the purpose of deducing an invariable standard, which should serve as unitary basis for the new system. This courteous proposition was not responded to by England, for reasons which it is not necessary now to consider. The French Academy, therefore, waiving the co-operation of England, proceeded alone, and after mature deliberation rejected the unit of the pendulum, and decided in favour of a standard to be deduced from the dimensions of the earth itself. An arc of the meridian, that comprised between Dunkirk and Barcelona, was measured in the most elaborate and careful manner, and by means of this arc, and of that previously measured in Peru, the length of the quarter of the meridian, or the distance from the pole to the equator (supposed at the level of the sea), was calculated. This length was sub-divided into ten million equal parts, and one of these parts was taken for the fundamental unit of the new system, and to this unit the name "*mètre*" (*par excellence*) was given, from the Greek word μέτρον, which signifies measure.

Objections have been urged again and again against the exactness of this terrestrial arc. We have even been told that the *meter* itself would have to undergo material alteration if a more accurate survey and a fresh system of triangulation were undertaken. Such objections, however, are more fanciful than real, at least as it regards the meter, which is really the only question we have to consider. The length of one minute, or sixtieth of a degree (called a nautical mile in French), is, according to Briot's Arith., equal to 1852 meters. This tallies with a geographical mile estimated in English yards, which is equal (in round numbers) to 2025 yards, the meter being equal to $39\frac{1}{3}$ inches nearly. Now if we multiply the former number by 60, and the product by 90, we shall have the length in meters of the quadrant of the circle: $1852 \times 60 \times 90 = 10000800$, which is 800 metres in excess of the supposed subdivision. Let us now suppose, for a moment, that the French *savans* had made an error equal to 800 m. in their calculation: this error, although great in absolute amount, is relatively small on the meter, with which we are concerned; the error (relative) would only amount to $\frac{8}{100000}$, *i.e.*, would be less than one twelve-thousandth ($\frac{1}{12000}$). We think this approximation quite sufficient for all practical purposes; and, taking all things into account, along with the spheroidal form of the earth, it is probable that the relative error is even less. Be this as it may, we need no longer concern ourselves about the original standard, whether it be exact or whether it be fanciful; such objections as those alluded to, are like dust in the balance when compared to the whole of this invaluable system. The standard with which we have to do is the model in platinum preserved in the archives at Paris, which can never be lost, for it exists not only in the primary unit, but also in those derived from it. And even were all the standards destroyed, if such a case were possible, they might again be recovered without the labour of a direct remeasurement of the terrestrial arc, by the known relation



Decimal Measures.

W West Lith.

BRITISH MUSEUM NATURAL HISTORY.

between the second's pendulum and the meter. Precisely with a view to establish the most efficient safeguard of the primary standard, Borda had determined with the greatest nicety the dimensions of the pendulum beating seconds at Paris, which in fact approach most nearly to those of the meter itself, being $0^{m\cdot},99385$, the difference therefore being less than $\frac{1}{100}$ of the meter. With these data, by a fresh determination of the length of the second's pendulum, invariable as this length is at the same latitude, temperature, and level (of the sea), a new standard meter, exactly equal to the original, could be constructed. The Academy had previously resolved that the unit of length, whatever might be its value, should form the basis of the new system, the prototype, to which all other units whether of surface, volume, or weight were referable; and accordingly we perceive how, in the most skilful manner, this luminous idea has been realised, and the unity of the whole system exemplified. It was also resolved that the number 10 should be the '*unique*' factor of the system, so that the different scales of measurement might be in harmony with our system of numeration, which is decimal, and all quantities be expressed in decimal numbers: hence the greatest facility and despatch were ensured in the necessary arithmetical operations. The Greek numerical prefixes, deca, hecto, kilo, myria, were chosen for the multiples, and the Latin, deci, centi, milli (by convention), for the submultiples or fractions of the various denominations.

Thus Linear Measure assumes the most simple and comprehensive form, as in the following sketch :—

Myriameter	10000	meters.
Kilometer	1000	,,
Hectometer	100	,,
Dekameter	10	,,
Meter	1	,,
Decimeter	$\frac{1}{10}$	,,
Centimeter	$\frac{1}{100}$	,,
Millimeter	$\frac{1}{1000}$	,,

Moreover, any one of these multiples or fractions may be employed as a distinct unit, whenever it is convenient, and decimalised accordingly. The French usually express great lengths in kilometers or even in myriameters; for example, the distance between two towns is said to be 32 myriameters and 5 kilometers, and this is written 325 kilom. (equivalent to about 203 English miles), and may be enunciated either way. The length of a canal is said to be 48 kilometers 7 hectometers, and this is written 48 k.m., 7 (equivalent to about 30 miles and a fraction). On the contrary, lengths very minute are reckoned by millimeters; thus the thickness of a mirror is said to be $8\frac{5}{10}$ millimeters, which is written 8mm., 5.

Surface.—The units of surface are the squares constructed on the units of length. The principal unity of surface is the square meter. Then we have the decameter square, hectometer square, kilometer square—and on the other side the decimeter square, centimeter square. As this is square measure, the units of surface are from hundred to hundred times greater, by definition; the value of each unit is one hundredfold that of the unit immediately inferior. Thus the square meter is equal to one hundred square decimeters, and so forth. For measuring land the principal unit employed is the square decameter, which then takes the name of are (from Latin area); the only units used in land measure are the hectare or 100 ares, the are, and the centiare or $\frac{1}{100}$ of the are. Thus an estate is said to consist of, 125 hectares and 47 ares; a garden, of 23 ares and 50 centiares; and these quantities are written :—

125,47 hectares. 23,50 ares.

The hectare is equal to $2\frac{1}{2}$ acres, nearly. The following tabular sketch will enable the reader to understand this very simple scale at a glance—

Hectometer square	Hectare = 100 ares.
Decameter square	Are
Meter square	Centiare = $\frac{1}{100}$
Decimeter square	
Centimeter square	

Cubic Measure.—A cube is a solid terminated by six equal squares, such as a die. By definition the units of volume in the metric system are cubes, which have for sides the units of length. The principal unit of volume is the cubic meter. On the one hand we have, in ascending order, the decameter cube, the hectometer cube, &c.; and on the other, in descending order, the decimeter cube, the centimeter cube, &c. Each unit is equal to one thousand times the unit immediately inferior in the scale. The whole series therefore forms a geometric progression—as do the foregoing—the ratio of which is 1000: the ratio of the linear series being 10; that of superficies, likewise, being 100. To measure a volume is to ascertain how many cubic meters it contains, and what, if any, fraction of cubic meter; or in other words, to ascertain how many cubic units of each order it contains, and it may contain 999 units of each order. Thus the same scale suffices to express both abstract and concrete numbers, and it depends on choice how many concrete orders are to be considered. This constitutes one of the chief beauties of this elastic and wonderful system. The same feature is observable in the two preceding scales of length and surface; but in the latter, two numerals must be set apart to each order, where more than one is considered, as in square measure, each order may contain upwards of 99 units. In the cubic scale, however, we must be careful to appropriate 3 ranks of numerals to each order when separately considered. An example will illustrate this principle. The following quantity 24507638,0750098 m.c. can be enunciated as a simple decimal number of one order (cubic meter), or we may imagine it partitioned into sections of 3 numerals, right and left of the comma, and enunciate the whole volume in units of the different orders *gradatim.* Thus: 24 cubic hectometers, 507 cubic decameters, 638 cubic meters, 75 cubic decimeters, 9 cubic centimeters, 800 cubic millimeters. Or shortly thus: 24 hectom. cub., 507 decam. cub., 638 m. cub., 75 decim. cub., 9 centim. cub., 800 mill. cub.

In France the cubic meter serves to measure stacks of firewood, and then it is called stere, the multiple of which in use is the decastere (10 steres), and the submultiple decistere, and even centistere ($\frac{1}{10}$ and $\frac{1}{100}$ of the stere).

Measures of Capacity.—The liter (equivalent to $1\frac{3}{4}$ pint nearly), is the principal unit of capacity for liquids and grain; its capacity is that of a cubic decimeter. The multiples of the liter are: the decaliter, hectoliter, kiloliter, or 10, 100, 1000 liters. The submultiples are: the deciliter and centiliter, &c., or the tenth and hundredth part of the liter. These vases are of cylindrical form, and made of tin when destined for liquids; in this case the height of the vase is double the diameter of the base. They are made of wood, and the height is equal to the diameter of the base, when destined for grain.

Weights.—The fundamental unity of weight is the gram; the multiples are the decagram, the hectogram, the kilogram, or 10, 100, 1000 grams. The subdivisions are the decigram, the centigram, the milligram, or the tenth, hundredth, thousandth part of the gram. The kilogram (equivalent to $2\frac{1}{5}$ lbs. avoird. nearly), is the weight in vacuo of a decimeter cube of distilled water at its maximum of density, *i.e.*, at 4° above 0 of the centigrade thermom. The standard in platinum of the kilogram is deposed in the archives of State in Paris. Since the kilogram is the weight of a cubic decimeter or of a liter of water, the gram (the thousandth part), is the weight of a centimeter cube of distilled water at its maximum of density. For great weights the quintal (metric) equivalent to 100 kilograms, is used; and for ships' cargo the metric ton, equivalent to 1000 kilograms. A vessel of one hundred tons is a vessel capable of carrying 100 thousand kilograms. Each of the units of weight, and also each of the measures of capacity,* has its double and its half, as by law established. We give in a table the corresponding units of volume and weight:—

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* See Plate IV.

Meter cube	Kiloliter	Metric ton	(1000 kilogs.).
Decimeter cube	Liter	Kilogram	(1000 grams).
Centimeter cube	Milliliter	Gram	
Millimeter cube	...	Milligram.	

We perceive that each series constitutes a decreasing geometric progression, the ratio of which $\frac{1}{1000}$. The cubes of the meter, decimeter, and centimeter, filled with distilled water, are equivalent in weight to the metric ton, kilogram, and gram respectively, and the relation established between volume and weight is of great importance in the mechanical arts and in trade. The specific gravity of a body, whether solid or fluid, as we know, is the relation or ratio of the weight of any volume of this body to the weight of an equal volume of water. Now, as we have a series of volumes and weights corresponding in the metric scale, expressed in single units, the investigation of the specific gravity of bodies, this being a constant quantity in each, is proportionally simplified. Assuming as unit of volume the decimeter cube, or liter, and as unit of weight the kilogram, as is the ordinary practice in the arts in France, then the specific gravity of a body is the weight in kilograms of a decimeter cube of this body. This simple process furnishes also an easy method of ascertaining the weight, and therefore value, of merchandise of large bulk; for the cubic dimensions of this bulk being found by direct measurement, as can be done by the metric scale better and more accurately than by any other, this volume, multiplied by the specific gravity of the substance, gives the weight of the merchandise in kilograms. In delicate measurement, such as in pharmacy and chemical analysis, the gram (along with its subdivisions) and its concomitant unit of volume, the cubic centimeter, are used. And in shipping, the metric ton and its corresponding unit of volume, the cubic meter, furnish the utmost advantage and facility in estimating either the tonnage or the cargo of the ship.

It is almost superfluous to contrast the unity and harmony of this unique system called *Metric* with our own grotesque scales of weights and measures. In the former, all the parts are subordinate to the meter, the primary unit; they all emanate from it, and radiate as from a common centre. Our standards, on the contrary, are not only arbitrary, but unconnected one with another; there is, moreover, no fixity about them, but like so many independent variables, they pass through different series of values from maximum to minimum, with the utmost caprice and nonchalance. We learn from Kelly's Universal

Cambist, that no fewer than 150 different pounds were in use in different parts of Europe before the introduction of the half-kilogram, which seems destined to supersede them all. The kilogram, however, has never varied; indeed, how could it vary, in any appreciable degree, without being speedily brought back to the metric standard?

Herein consists the luminous idea of the French *savans,* in rendering all the parts of the new system homogeneous—to wit, that they anticipated any subsequent variations in the all-important standards of capacity and weight, and prevented this by making these standards, dependent on each other, to depend on the metre, so that they could not vary as long as it remained intact; and if any standard were lost, it could be recovered from the remaining.

The second important decision of the French Academy of Science was, that the new system, in all its branches, should have but one divisor, and that 10, or a power of 10, according to the necessity of the scale. This, for practical purposes, is perhaps the most important part of the great reform, for besides the infinite simplification introduced thereby in all arithmetical operations connected with the metric scales, this solitary factor would itself, better than any specific, cure the mania of tampering with the various scales in order to suit local caprice and prejudice. The standards themselves could never have varied, as they once did in France, and now do in England, had there been but one divisor (especially if that one were the radix of the system of numeration); for the evil of a multiplicity of divisors reacts on the standards themselves, and renders them uncertain. Let any one glance at our tables of weights and measures with their innumerable divisors, chiefly of the worst kind, and he will there see evidence of this principle. Let him look at square measure, and at the innovations there introduced to simplify, if possible, but at all events to render this table less obnoxious; then let him pass on to cubic measure, and solid measure, with their addenda in appalling number. If we interrogate a hapless surveyor or architect, or those engaged in the iron trade, we learn the enormous difficulties they have to contend with in making their calculations; oftentimes each is obliged to supplement the tables, or shift for himself as he best may, having no Ariadne's thread to extricate him from the labyrinth in which he becomes involved. And if this be true of professional men, how are non-professional men situated? Generally speaking, they must receive upon trust those results which concern them, and which they cannot verify, the which is a great evil, and opens a wide door to every species of fraud and contestation. Our readers are probably aware of the vast improvement the metric system has introduced, in giving uniformity and stability in place of so many jarring scales and standards. Now let us consider for one moment the amazing simplicity superinduced, by making the number 10 the sole multiplier and divisor in the new system. The consequence is that the laborious process of compound multiplication and division, of reduction from higher to lower denominations, and *vice versâ*, is virtually abrogated; the arithmetical process is performed mechanically. A mere point, or comma, inserted in a number, suffices for multiplication or division by a power of 10, and supersedes the necessity of any other arithmetical operation, except the simply mechanical one of advancing the comma forwards or backwards, as the case may be. We trust our readers are all well acquainted with this important principle in arithmetic; but lest there should be any to whom this is new, we must be pardoned if we give an illustration. For example, let us consider a short number in the metric scale, such as the following:—35 meters, 6 decimeters, 3 centimeters. Now, as each order of units is equal in value to 10 units of the succeeding order (by definition) it is evident the number supposed is equal to 35 meters 6-tenths and 3-hundredths of a meter, or to 35 meters and 63-hundredths of a meter, and is therefore a decimal number and falls within the abstract decimal scale, although expressing a concrete quantity, as was before remarked: for simplification, then, the given number is written 35m.,63, and the only reduction consists in making the subordinate units fall into their proper column.

Had we to multiply this number by 10, it is done by passing the comma one rank to the right; thus, $356^{\text{m}\cdot},3$; (by 100, two ranks to the right, thus, 3563 m.). The reason of this is obvious, and arises from 10 being the basis of our system of numeration, so that a numeral (6) placed on the right of a number (35) in effect multiplies this number by 10: the fraction $\frac{6}{10}$ is itself multiplied by 10 in expunging its denominator, and the last fraction $\frac{3}{100}$ becomes now $\frac{3}{10}$: hence the whole number ($35^{\text{m}\cdot},63$) has been multiplied by 10, in multiplying each part of it by 10, and this has been effected by a simple displacement of the comma one rank to the right. Had we to divide the same number $35^{\text{m}\cdot},63$ by 10, we move the comma one rank to the left: thus, $3^{\text{m}\cdot},563$ (3 meters, 5 decimeters, 6 centimeters, 3 millimeters, or 3 meters, 563 millimeters), and we see that each cipher in the proposed number remains unchanged, but with tenfold less value; the whole number has therefore been divided by 10 by the simple displacement of the comma one rank to the left. Had we to divide by 100, this is done by passing the comma two ranks to the left; or by any power of 10, and it is done by passing the comma as many ranks to the left as the index or exponent of the power contains units; and if the number proposed does not admit of this, zeros must be added to its left. For instance, had we to divide the number proposed $35^{m\cdot},63$ by 10^3 (or 1000), the quotient becomes $0^{m\cdot},03563$, equal to 35 millimeters, and 63-hundredths of a millimeter, *i. e.*, a thousand times less.

Let it be remembered that the denominator of a decimal number is unity, followed by as *many zeros* as there are ranks of decimals.

The nomenclature of the new system has been severely criticised in England. Its denominations have even been called barbarous, a reproach we scarcely expected, inasmuch as these are derived from the Greek. But common people, it is urged, are not learned and cannot understand such strange designations. The answer is that the tradesman or artizan will soon understand what he requires, and how to name it; if he cannot enunciate the numerical quantity of the object he requires in Greek and Latin prefixes, he will resort to English numerals to express its value. But we have conclusive evidence on this point. English workmen engaged on the Continent, in railways and other works, have learnt, and do learn, all they require of the metric (ay, and the monetary) system of France, with the greatest facility, and when once learnt they prefer it to our own. But the advantage of the twofold classification in the metric system is too great to be abandoned or departed from on trivial grounds. The divisions and subdivisions of the various scales are so clearly defined by this double nomenclature of Greek and Latin prefixes, as could not be effected by any other process. To change this nomenclature would lead to ambiguity; for instance, a decameter means 10 meters; but if we were speaking of a decameter square (we should mean not 10 but 100 square meters), and were to translate the name of this unit into English, such translation would most probably engender confusion.

In conclusion, the metric system has been tried already and proved, not only in France, but in Belgium, in Switzerland, in Italy, in parts of Germany, and in America. In Tuscany we read of its adoption in a moment, as if by magic, and that it was in general use, as if it had existed in that country for half a century. In short, according to the unanimous testimony of competent witnesses, the system is pronounced to be the most perfect ever invented. By the force of its intrinsic merits, it is progressing steadily through the civilized world, and seems destined eventually to supersede every other system, whether good or bad. Under these circumstances we, as a commercial nation, dare no longer ignore this great reform; no longer slight this new competitor, that appears on the scene with unfettered limbs: we must make him ours—our auxiliary, and shake off the old trammels, if we expect to continue victors in the race. Our men of science, in compact body, our superior chemists and engineers, have given their voice in favour of the new system, and are even obliged to use it, *nolens volens,* in order to ensure the requisite accuracy in their calculations; they therefore desire to be freed from the old encumbrances. The associated Chambers of Commerce have unanimously petitioned Parliament on the same subject. We subjoin one or two clauses of this petition:—

> That even the weights and measures authorized by law in the United Kingdom are found to be most inconvenient for the various purposes of trade and social intercourse, on account of their cumbrous division, the great waste of time they entail in calculations, the liability to error they produce, and the want of homogeneity in all their parts.
>
> That the metric system being established on a scientific basis, and having been found exceedingly well adapted for all practical and scientific purposes, and admitted into many countries of Europe and America with unexceptionable advantages, has the best recommendation for its adoption in the United Kingdom, and, in the opinion of your petitioners, is likely to produce a decided boon to the whole community.
>
> That having regard to the increased intercourse with the Continent of Europe likely to ensue in consequence of the Treaty of Commerce recently concluded with France, from the reduction of postage, and from the abolition of passports, it is all important that the weights and measures employed in international transactions should be assimilated as much as possible in all countries. That, in the opinion of your petitioners, this is a most favourable opportunity for commencing the change; the public mind in this country being now sufficiently prepared for it, &c.

Many other arguments might be urged in favour of the proposed change (among them not the least is, the solid advantages that education, both commercial and scientific, would derive), which our want of space forbids us to notice. Finally, however, a Bill has passed in the last session of Parliament, entitled, "An Act to render permissive the Use of the Metric System of Weights and Measures, 29 July, 1864." It is to be hoped that the subject will not be set at rest by this Act (or we shall have made a transition from bad to worse), and that in the meantime all will avail themselves readily, whenever the occasion presents itself, of the new concession. We ought likewise to assimilate our terms and symbols as much as possible to those employed on the Continent, so that the same word, or the same symbol, may express the same meaning here as there. Otherwise we shall still remain isolated, not only physically, but morally, as heretofore.

Et penitus toto divisos orbe Britannos.

The language of science ought to be universal, and to be so, it should be synonymous—so should that of commerce likewise; but in consequence of our forgetting this precept, and neglecting to assimilate, as much as possible, our technical terms and symbols to those of the rest of Europe, our men of science are comparatively unknown, even in France, and their works are not sought and appreciated as they ought to be, and would be, if greater uniformity were observed. As a general rule, a comma is used on the Continent to separate the parts of a decimal number. The comma is also used, as with us, to separate thousands in whole numbers; but this occasions no ambiguity, as may be seen at once on referring to a French statistical paper. Whereas by employing, as we do, the period (·) in the middle of a decimal number, we may cause ambiguity to foreigners: they may even suppose we are using duodecimals. But this is of minor importance compared to the glaring anomaly of using the word cipher as synonymous with zero, while the rest of the world understand cipher to mean (what Dr. Johnson defines it in the 1st defin.) "an arithmetical character, a figure:" we use the verb, to cipher, properly, and ciphering—then why not the noun? If we wish to be readily understood by our Continental neighbours, than which nothing is more important in every species of commerce, we should at least employ their own words, or words of the same etymology, synonymously. Hitherto we have said nothing about the coinage of France, although the new system would have been incomplete if this important matter had been omitted. The French monetary scheme, therefore, forms an integral part of the Metric system. The fundamental unit is the franc, which is a coin of the weight of 5 grams, composed of 9 parts of silver and 1 of copper. The sub-divisions are the decime ($\frac{1}{10}$ of a franc or 10 centimes), the centime ($\frac{1}{100}$ of a franc). In the Permissive Act of last session nothing is said about decimal money, and yet the introduction of decimal coinage into England interests Englishmen directly, and foreigners indirectly, quite as much as any part of the Metric system. Our time and space being exhausted, we cannot now enter on this momentous question.

We subjoin the important clause in the Permissive Act along with the Metric Tables, and their correlative values in English denominations.

Notwithstanding anything contained in any Act of Parliament to the contrary, no Contract or Dealing shall be deemed to be invalid or open to objection on the ground that the Weights or Measures expressed or referred to in such Contract or Dealing are Weights or Measures of the Metric System, or on the Ground that Decimal Subdivisions of legal Weights and Measures, whether Metric or otherwise, are used in such Contract or Dealing.

SCHEDULE *to which this Act refers :—*

MEASURES OF LENGTH.

Metric Denominations and Values.	Metres.	Miles.	Yards.	Feet.	In. Dec.
Myriametre	10,000	6	376	0	11·9
		or	10,936	0	11·9
Kilometre	1,000		1,093	1	10·79
Hectometre	100		109	1	1·079
Dekametre	10		10	2	9·7079
Metre	1		1	0	3·3708
Decimetre	$\frac{1}{10}$				3·9371
Centimetre	$\frac{1}{100}$				0·3937
Millimetre	$\frac{1}{1000}$				0·0394

MEASURES OF SURFACE.

Metric Denominations and Values.	Square Metres.	Acres.	Square Yards. Dec.
Hectare, i. e. 100 Ares ...	10,000	2	2,280·3326
		or	11,960·3326
Dekare, i. e. 10 Ares ...	1,000		1,196·0333
Are...	100		119·6033
Centiare, i. e. $\frac{1}{100}$ Are ...	1		1·1960

MEASURES OF CAPACITY.

Metric Denominations and Values.	Cubic Metres.	Qtrs.	Bls.	Pks.	Gls.	Qts.	Pts. Dec.
Kilolitre, i.e. 1000 Litres...	1	3	3	2	0	0	0·77
Hectolitre, i.e. 100 Litres ...	$\frac{1}{10}$		2	3	0	0	0·077
Dekalitre, i.e. 10 Litres ...	$\frac{1}{100}$			1	0	0	1·6077
Litre	$\frac{1}{1000}$						1·76077
Decilitre, i.e. $\frac{1}{10}$ Litre ...	$\frac{1}{10000}$						0·176077
Centilitre, i.e. $\frac{1}{100}$ Litre ...	$\frac{1}{100000}$						0·0176077

WEIGHTS.

Metric Denominations and Values.	Grams.	Cwt.	Stones.	Pounds.	Oz.	Drams. Dec.
Millier	1,000,000	19	5	6	9	15·04
Quintal	100,000	1	7	10	7	6·304
Myriagram ...	10,000		1	8	0	11·8304
Kilogram ...	1,000			2	3	4·3830
		(or 15432·3487 grains)				
Hectogram ...	100				3	8·4383
Dekagram ...	10					5·6438
Gram	1					0·56438
Decigram ...	$\frac{1}{10}$					0·056438
Centigram ...	$\frac{1}{100}$					0·0056438
Milligram ...	$\frac{1}{1000}$					0·00056438

RECENT INVESTIGATIONS INTO THE NATURAL HISTORY OF THE RED CORAL.

BY THE EDITOR.

MORE than a hundred years have rolled away since a young French physician asserted that the so-called coral-plant was really an animal; and during that immense interval few facts have been added to his original discoveries till within very recent times. Peysonnel, to whose wonderfully acute observation the knowledge we now possess is in great part due, shared, like most great men, but little of the reward due to his valuable and laborious researches. His discovery, when announced to the French Academy in 1827, was, if not treated with considerable contempt, at least rejected in the most decided manner by Réaumur and the other distinguished savans of the period. But Peysonnel loved science for itself and was not to be discouraged, so he addressed his fellow-citizens of Marseilles, hoping that at all events they, many of whom owed their very lives to the exertions of his nobly philanthrophic father, would be led to accept his opinions. Alas! the result proved as unfavourable as the former one. How could the people of a provincial town give credence to statements which had been subject almost to the ridicule of the philosophers of the metropolis? He did not, however, despair. There has long been a refuge for the persecuted politicians of European states. England has ever received with kindness and hospitality the victim of oppression who has fled from an ungrateful country. Nor has she rejected the persecuted man of science when he has sought her protection. To England, then, the much-wronged Peysonnel appealed, and Englishmen responded to his appeal, with an earnestness which must ever be recorded to their credit. His discoveries were detailed at length in memoir form, and were published in the Philosophical Transactions of the Royal Society for 1756. Since that date little was done towards clearing up the natural history of the coral creatures, till in 1860 the French Government sent out M. Lacaze-Duthiers to inquire into the subjects of the structure, growth, and development of the coral in the Mediterranean. This naturalist, who is well known to our scientific readers for his important researches among the mollusca, devoted himself for three years to the study of this group of polyps, and has now published all the information which he acquired during thirty-six months of cautious and well-conducted experiment and observation.*

Every one is familiar with the general contour of the red coral (*Corallium rubrum*). It is to be seen in almost all collections of natural history specimens, and presents to the eye the appearance of a branching tree-like object, composed of coloured mineral matter. As we walk through a museum and observe it beneath a glass shade, and, as it were, rooted firmly to some piece of rock or stone, it certainly seems hard to think that what we see belongs to the animal world. Yet such is unquestionably the case. Let us, therefore, in the first instance give such a general description of this anomalous animal as shall lead to some idea of its animality, before we proceed to deal with the history of its strange existence, and the peculiar structure of its living frame-work.

The branching object that we are now examining is, when in a condition of life, covered with a soft and fleshy crust of a brick-red colour, and which invests every portion of its surface. This bark-like tissue exhibits here and there a number of little elevations, and from these, at times, project several beautifully transparent short tubes, crowned with star-like coronets, having the semblance of the clearest crystal. These projecting bodies are genuine animals, and to them the term *polypites* has been applied by our distinguished countryman Professor Huxley. Such, then, is an outline sketch of our coral—a brick-red branching object covered with skin, and harbouring numerous *polypites*. The latter are actual animals; their crown of tentacles enjoys the greatest freedom of voluntary motion, and guards the mouth, which can be opened or closed at the desire of the individual, for the entrance or imprisonment of all luckless infusoria which have come within the grasp of the tentacular organs. They can digest their food too, and are provided with a proportionately large stomach, which lies in the central cavity of the body. Sometimes the entire surface of the coral-mass is covered with these exquisitely translucent animal flowers; but upon the slightest provocation they disappear and play the recluse. They must, therefore, be provided with muscular and sensational power. It is evident that they are sensible of anything which is uncongenial, and that they have the faculty of withdrawing themselves from its influence. For, the moment they are irritated in they all go; the little projections from the brick-red mass become more prominent, and are all that is left to the observer of the glorious colony of beings which had a few moments before been enjoying the conditions of out-of-door life.

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* "Histoire Naturelle du Corail; Organization; Reproduction; Pèche en Algérie: Industrie et Commerce." Par le Docteur H. Lacaze-Duthiers. Paris: Baillière. 1864.

One of these *polypites* may choose to withdraw from exposure to the surrounding water, and he can carry out his desires without considering the opinions of his neighbours. He can extend his tentacles and body or retract them as it suits his pleasure, without affecting his fellow *polypites*. Hence it follows that he possesses a species of individuality; and yet he is only a member of a community connected by the closest organic relationship. His fleshy framework is continuous with that of the other members of the fraternity. He cannot, therefore, be regarded as an entire animal, but only as a portion of one, which is, so to speak, functionally independent; that is to say, *a b* and *c*, though each is capable of feeding and exercising himself, is still part of one creation, which we may write down as *abc*. The separate *polypite* is to the entire colony as the flower of a plant is to its fellow flowers, and to the leaves, branches, and stem which compose the vegetable. If we were to endow the flower with the faculty of procuring and digesting food, we should convert it into a *polypite*. The following tabular arrangement will convey an idea of what we mean :—

Coral.	*Plant.*
Hard mineral framework.	Hard woody stem.
Soft fleshy covering.	Soft bark and cambium.
Polypites.	Flowers.

The Siamese twins form a good analogy. One *polypite* can perform movements independently of his brother, but he cannot move away from him. Likewise he can feed, but in both cases poison taken in by the one would be destructive of the other or others.

Having said so much in regard to the external form and characters of these animals, we may now proceed to examine their general and microscopic anatomy, and the modes in which they perform their various functions. It will be necessary at the outset to employ definite terms in order to avoid confusion. The fleshy covering which is of brick-red colour will be spoken of as the *Sarcosome* (*σὰρξ*, flesh; and *σωμα*, body); the hard calcareous framework as the *Polypidom* (*polypus*, polyp; and *domus*, house); and the entire colony as the *Zoanthodeme* (*ζῶον*, animal; *ἄνθος*, flower; and *δημος*, the people). Then again, since there are two modes by which these animals can increase, viz., by budding and by egg, we shall term the individual originated by the first process a bud-polypite and that by the latter an egg-polypite.

The polypite is not merely contained within the cup-shaped depression (calyx) of the sarcosome, but is absolutely connected with it at its base, and when it is retracted is completely covered by it. On looking at one of the papillary elevations of the sarcosome which immediately overlies the retracted individual, we perceive that it is marked by eight horizontal groves or depressions which radiate from the centre, in which is observed a veryslight aperture (Pl. V. fig. 2). The latter it is which widens when the polypite extends himself, and it then presents a large orifice beautifully crenated at its borders (Fig. 3 *d*), the eight groves having as it were been unfolded so as to form as many elegant festoons which correspond in position to the creature's tentacles, which are of exactly the same number. The object of this arrangement is obvious; it allows the tentacles alone to be protruded when the creature is disinclined to extend himself to any distance from the outer surface of the sarcosome. Turning now to the polypite itself, we find it to consist of a tube (*c*) of an exceedingly delicate transparent membrane, the upper part of which expands a little so as to form a kind of disk (*b*), which is termed the *peristome* (*peri*, around; *stoma*, the mouth); to this structure the tentacles are attached, and form an elegant and radiating crown which surrounds the mouth. These tentacles are not tubular and simple as in the sea-anemone, they are somewhat flattened horizontally, and have two rows of smaller plumules projecting from their borders, these being in their turn faintly tuberculated. The plumules do project rectangularly from the edges of the tentacles, but are arranged in a somewhat oblique manner, and are directed in a line from above downwards and from within outwards. They can be moved separately or collectively at the will of the animal, and are sometimes arranged round the mouth like the spokes of a wheel, while at others they form a graceful, vase-like group. When a thin vertical section of a tentacle is placed under the microscope, the arrangement of the tissues can be very clearly observed. There are two distinct layers of membrane, an outer and an inner: the former is made up of a fine granular basis embedding small oval cells and having scattered among them larger vesicles which appear to have striated walls; these especially are important, for they are the bodies known as thread-cells, in fact, the stinging organs which are found so abundantly and well developed in the jelly-fishes and which procured for that group the name of *Acalephæ* or sea-nettles. When one of these is isolated it is seen to be in reality a double cell (an external or protective envelope, and an internal case in which the peculiar stinging thread is coiled) whose walls are perfectly concentric. The inner membrane is composed of cells of a very large size, and which are not packed closely together as in the former case, but are arranged in rows which form curious polyhedral spaces; these cells are clothed with cilia (delicate filaments), and undoubtedly share in promoting the movement of the fluid which fills the general cavity of the body. Leaving the tentacles we find the mouth represented by a slit guarded by two soft lips. The direction of this slit is not as many writers declare, from one tentacle to that immediately opposite; but, on the contrary, has its axis intermediate between two tentacles: it occupies about one half of the diameter of the peristome and leads directly into a gullet which must be regarded as the true stomach. This is a transparent tube placed in the very centre of the animal, and closed at its extremity by a sphincter muscle, which when not in action leaves the end of the gullet open, and thus forms an aperture of communication between the external medium (the water) and the internal cavity of the polypite. The latter we must now glance at: it is a chamber or space bounded externally by the outer wall of the body becoming lost below in the tissue of the sarcosome, and chiefly of interest from the circumstance that it is divided above into eight small compartments. This division is effected by membranous partitions which are continuous outside with the general wall of the body and within with the outer surface of the gullet or stomach; at the termination of the latter organ they of course lose their inner connection, and then appear as membranous folds floating in the general cavity, and attached by one border to the wall of the body. Each chamber is continuous above with a tentacle, which, by the way, does not terminate in an aperture, as is generally imagined. The most remarkable feature in the anatomy of the septa is that they have attached to their upper part a number of thread-like coils which resemble the folds of the intestine and to which the reproductive vesicles are attached (fig. 2 *r*). Next we come to the consideration of the sarcosome (fig. 1 A), and in this we find three distinct constituents: 1st, a matrix or bed of granular or structureless material; 2nd, scattered through this a number of crystalline particles; and 3rd, peculiar systems of tubes. The matrix is already disposed of, it lodges all through its substance thousands of crystalline particles, having the characteristic tint of the coral and being of minute size; to describe their form would be, as M. Lacaze-Duthiers very truly observes, exceedingly difficult; but some notion of their outline may be conceived by fancying a pyramid with a square base, whose summit represents a kind of pedicle the edges of which are covered with two linear series of small projections, and whose base is irregular, slightly prominent, and covered with spines itself. Besides these bodies which are scattered all through the sarcosome, there are two series of vessels—an external and internal. The inner vessels are tubes of large bore and with very distinct walls; they run parallel to the axis of the polypidom, and occasionally anastomose or communicated by transverse branches; they are situate most internally, and lie so close to the hard framework that as this is being developed it leaves grooves in which these canals lie (P). The other series of conduits is composed of vessels of much smaller calibre and which do not pursue any special course, but traverse the sarcosome in every possible direction and communicate constantly with each other and occasionally with the larger series. Their walls are hardly distinguishable, for they appear to be merely tunnels through the fleshy tissue of the sarcosome; they communicate with the general cavity of the polypites' body, which the larger channels do not; and both classes contain a whitish fluid known to the coral fishers as the milk, but which is really the blood of these creatures, and contains both spicules and corpuscles floating through it.

The polypidom, which is the portion of the zoanthodeme most known to readers, is composed of calcareous matter combined as a tissue with organic matter. Its structure is best seen by making a transverse section and submitting it to microscopic examination. The observer will then perceive that the central portion of the stem is occupied by a homogeneous coloured mass of mineral character, round which there appears to be a ribbon-like fold of more highly tinted matter, which does not form a circle but some irregularly oval figure; between this and the circumference one sees alternate concentric rings of strongly and faintly tinted material which are divided by numerous radiating dark lines of extreme tenuity. These various appearances may be thus accounted for: the central irregularly fold ribbon-like mass, is the first hard part developed by the young *egg-polypite;* this has had mineral matter deposited all round it year after year, but the deposit went on with greatest rapidity in the depressions, and hence after a while a circular outline was produced, the several rings indicate the successive depositions, and the dark radiating lines point to the grooves in which in earlier days the central large canals surrounded the stem.

The foregoing remarks apply to the animal as it is. We have now to inquire how is the creature produced. This involves an examination of the reproductive system. The coral is unisexual, bisexual, and hermaphrodite. Sometimes a colony is met with which contains either all males or all females, at others we find a zoanthodeme, some of whose branches contain males, some females; and it occasionally though rarely occurs, that we detect a single polypite, in which the apparatus of both sexes are present (fig. 2 B'). In all cases the arrangement and structure of the organs are similar. The ova and sperm cells are both united to those singular, coiled-thread-like masses which we saw attached to the partitions of the general cavity.

The egg (o) is a large spherical translucent body with its *yolk, germinal vesicle,* and *spot,* and is enclosed in a capsule, which is attached by a short pedicle to the structures we have referred to already. The sperm cells are likewise contained in a capsule (t), which, as in the case of the ovum, is connected by a stalk with the thread-like masses. Its capsule, however, unlike the ovum, is not of a regularly spherical form, but is rather heart-shaped or triangular; the contained sperm cells are of an oval figure, and when crushed discharge a cloudy liquid, which is seen under the microscope to consist of thousands of well-marked zoosperms with the characteristic oval heads and attenuate tails.

When the organisms produced in both the reproductive organs combine, the result is the fertilization of the ova, which then become embryoes or young coral. But in order to convert a fertilized egg into a larva it is necessary to hatch it, and this process takes place among coral animals within the general cavity of the polypites' body (fig. 3 B″ *f—g*); and when it has been accomplished, the young coral in the form of a small white worm just perceptible to the naked eye, is expelled through the mouth of its parent and henceforth has to go through life on its own account (B *a*). Being clothed externally with cilia it is enabled to move rapidly through the water, which it does for some time until it has found a suitable locality in which to settle down. When swimming it is like an elongated cylinder one of whose extremities is rounded and the other tapering, but when it is at rest the form alters, and one end becoming inflated its *tout ensemble* is that of a balloon. Very soon an absorption of tissue takes place at one end and a mouth is thus developed, and it now thinks of subsiding into coralhood. Having discovered some foreign body it becomes attached to it by a sort of mucous exudation, and rapidly increased laterally at the expense of its vertical measurement. Now, a number of spicules become developed, and these arranging themselves in a kind of horseshoe form constitute the first rudiment of the hard framework to which has been given the name of polypidom. The further processes consist in the development of sarcosome from the lateral portions, the formation of new polypites (bud-polypites) by germination, and in this manner the creation of a new zoanthodeme.

This, then, is a brief history of the coral, its life, structure, and development. It is abundantly distributed over the Mediterranean sea-bottom, and forms one of the most valuable industrial resources of the adjacent countries. There are several methods adopted for the capture of the coral, and each plan is considered by those who pursue it to be the most profitable and convenient. Perhaps the most common engine for the dredging of coral is that used by those who carry on the fishing on the coast of Algiers. This consists of a frame composed of two beams of timber about six feet in length arranged crosswise, and having a heavy weight attached below the point of intersection; to the extremities of the beams are attached nets of a coarse material and about a yard in depth, and finally, the whole machine is fastened by a ring at its centre to a powerful rope, the other end of which is connected to the capstan of a boat. By pulling this apparatus over that portion of the sea-bed in which the coral exists, the branches are smashed off from their rocky attachments, and becoming entangled in the network are afterwards brought to the surface and removed. The Spaniards use a kind of instrument called a *gratte*, whose principle is somewhat similar, but in which iron projections are employed, and a machine of like kind though slightly modified is the *salabre*, which is now seldom employed. Indeed it is considered by those competent to judge in such matters, that the employment of *engines* composed of iron is highly detrimental to the coral, inasmuch as it destroys even those parts which it does not remove. The *scaphandre* is simply a kind of clothing similar to that used by ordinary divers, and from the head-piece of which tubes proceed to allow of the entrance of pure air and exit of the respired gases, the former being blown in by an apparatus contained in the boats. According to M. Lacaze-Duthiers, this appliance cannot be employed with advantage, as, besides the constant danger attending its use, the weight and pressure are too great, and the surface of the sea-bottom too rugged to admit of its being used profitably or conveniently. A species of diving-bell has also been tried, but for the reasons above stated it is even more objectionable than the *scaphandre*.

The fishing on the Algerian shores is very extensive, and employs over two hundred boats, ranging in burden from sixteen to four or five tons. The value of the coral annually collected by them has been variously estimated. Thus we find that according to the statistics of the compilers of the Catalogue of the Exhibition of 1862, the value of the coral fished annually should amount to 4,448,000 francs; for there were 204 boats engaged in the fishery in 1860, and according to the London statistics the average per boat would be about 23,000 francs. This estimate, however, M. Lacaze-Duthiers shows to be far beyond the mark. In the year to which we have referred the weight of coral taken amounted to 29,888 kilogrammes, and the value of this, according to calculation, was 1,448,950 francs, or about £60,372 of our money. It appears to be the opinion of all those conversant with the character of the fishery, that it is, at present, owing to the inefficient protection it receives, in a state of gradual decay. There is good reason, too, for this view, for there is no doubt whatever that several very valuable coral beds have been exhausted of their supply even within the present century. In 1807 three important beds were discovered near Pianosa, and were completely exhausted as early as the year 1814; and in like manner have the once valuable formations on the coast of Monte Christo been completely annihilated.

This being the present state of the coral fishery, what can be effected to improve it? To this question there are two replies: 1st. Preserve the existing coral beds and their young by instituting a "close season;" and 2nd. Extend the coral beds by sowing localities now unproductive, with the larvæ of the polypites as in the case of oyster-culture. The close season should begin in spring and end in autumn, and the fishing should only be carried on during the remainder of the year. Such is the conclusion at which M. Lacaze-Duthiers has arrived after a careful and continued study of the period of gestation. He has invariably found the polypites laden with ova and zoosperms during the months of May, June, July, and August, but he has failed to detect them in specimens examined during the winter months of the year. With regard to the artificial culture of the coral, it may be said that the subject is as yet in its infancy. But few experiments have been tried, and the results of those made up to this have not been attended with very favourable results. In September, 1861, three earthenware vessels were thrown into the sea; one of them was examined in 1862, and found to be coated only with Bryozoa Annelida, &c. The other two were taken up some time later, and were said to have been coveredwith several specimens of young coral which had attained considerable sizes. It is evident that but little reliance can be put in such unsatisfactory results; but there appears to be sufficient *à priori* evidence to warrant the conclusion that the coral can be cultivated artificially with as much success as the oyster has been propagated under the productive system of M. Kemmerer.

There appear to be four kinds (not species) of coral recognized by the merchants of the Mediterranean:—1st, *Corail mort ou pourri*. This is constituted of the roots of the coral and those portions which have not been broken off by the engine; it is extracted by means of powerful pincers, and generally fetches from 5 to 20 francs per kilogramme.* 2nd, *Corail noir*, which is merely a variety of the red coral into which the black colouring matter of mud has penetrated to a sufficient depth to render it fit for the manufacture of ornaments of mourning; this kind is worth from 12 to 15 francs the kilogramme. 3rd, *Corail en caisse :* this is the commonest variety and includes pieces of every possible size, from the merest points to the largest branches. The price varies exceedingly, being 45, 50, 60, and 70 francs the kilogramme, according to the quality. 4th, *Corail de choix :* this includes the finest and largest specimens which have been selected from the mass. Consequently, it is exceedingly difficult to fix its exact value, as the manufacturer only is capable of appreciating the samples. The price varies from 400 to 500 francs per kilogramme. There is another variety which, from its very delicate pink hue, has been termed *Peau-d'ange :* this is the most valuable of all, and is much prized by the Italians, M. Lacaze-Duthiers having seen an exceedingly small unchiselled specimen purchased at the enormous price of 115 francs.

From what we have already written, sufficient can be gathered to show the immense importance of the coral fisheries as a branch of French commerce. But we apprehend there is something more than this to be learned from the foregoing paragraphs. The coral is an animal which can be easily propagated in seas where the temperature is equal to that of the Mediterranean. Such seas abound in the colonies of Great Britain. Is the subject therefore worthy of the consideration of the Government? Does it behove us to create new resources as well as to develop existing ones? If so, then, in our opinion, is the matter one which deserves immediate and serious attention, and as we have already inquired in the cases of the oyster and the herring, so now also we would ask in the instance of the coral—are we to cultivate it?

EXPLANATION OF PLATE V. (AFTER LACAZE-DUTHIERS).

Fig. 1. Adult Zoanthodeme. E, part of epidermis detached from sarcosome; A, sarcosome detached from polypidom, and showing polypites (B) connected with the stem; P, grooves for the longitudinal canals.

Fig. 2. Portion of coral enlarged, showing two polypites divided horizontally; one, (B) is female, and encloses only eggs (*o*). The other (B′) is hermaphrodite, and exhibits the radiating partitions (*r*) enclosing an egg (*o*) and capsule of zoosperms (*t*).

Fig. 3. Portion of coral-branch very much enlarged, showing the polypites and larvæ. B, a polypite showing larvæ (*a* and *e*) escaping from the parent's mouth. B″, a polypite contracted, the larvæ (*f* and *g*) being seen through the transparent walls. B′, larvæ set free, the polypite having been cut open.

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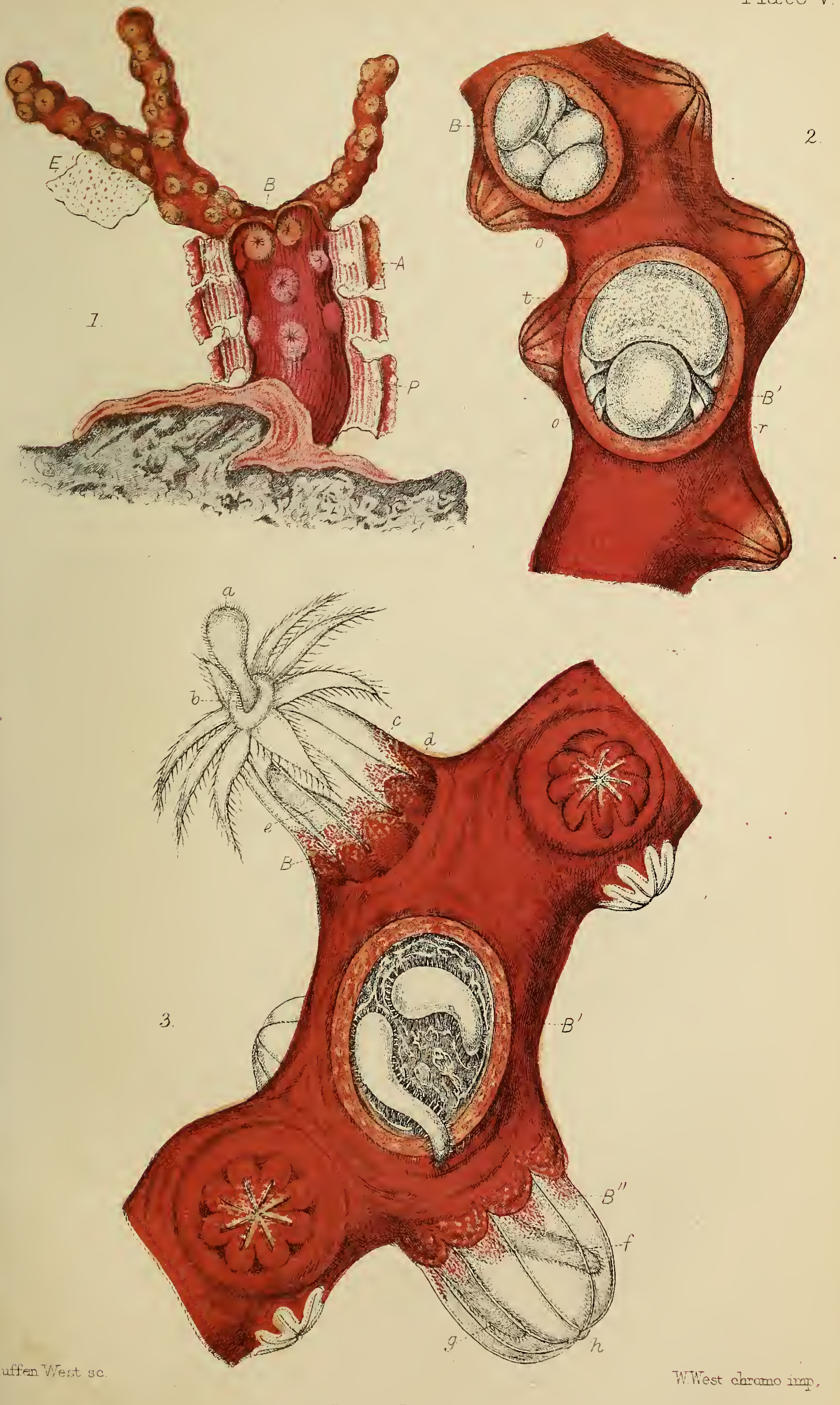
* A kilogramme is equivalent to 2·679 lbs. Troy.

Plate V.



Tuffen West sc.

W.West chromo imp.

Red Coral.

BRITISH MUSEUM NATURAL HISTORY

WHAT IS A STIMULANT?

BY FRANCIS E. ANSTIE, M.D.

THE popular idea of the mode in which stimulants influence the animal organism may be briefly summed up. These agents are supposed to quicken vital motions—muscular, nervous, secretory, circulatory, &c.; and the degree of quickening is supposed to indicate the amount of stimulation. This notion is so entirely incorrect that physiologists can hardly do better service to the public than by helping forward a better understanding of this fundamental question in vital science.

If the word stimulus is to be retained in use at the present time it must be employed only in a figurative sense. We have left behind us the days of a metaphysical physiology which assumed the existence of a mortal soul presiding over the functions of the body, and possessed of emotions, in virtue of which it responded to the impressions of stimuli. We are leaving behind us, too, inevitably, though with reluctance, the unsatisfactory substitutes for the "mortal soul" which we have created by employing dynamical terms, such as "vital force" and the like, which imply, in fact, only the appearance and not the reality of a change from the old metaphysical method of speculation. It is to be hoped that, for the future, we shall cease to employ that "combination of the *petitio principii* with the *argumentum in circulo*"* which first assumes the existence in the organism of a capacity of being stimulated, and then takes the licence of a traveller in fabulous regions to describe the reactions of an unknown and unknowable *vis vitæ*.

If stimulus mean anything in the present state of physiological science, it must certainly signify that kind of agent which *restores natural functions to their natural level and mode of action.* Consequently it will be applicable with far greater frequency to an action which delays rather than to one which accelerates the speed of vital motions. No fact is more conclusively demonstrated by modern physiology and clinical observation than this, that vital feebleness, in the great majority of instances, betrays itself by *hurry* of the vital motions; and the first indication of returning strength is the return of a calmer and more equable rate of functional move-

* Coleridge.

ment. In truth, the only idea of "life" which can be of the slightest advantage to practical physiologists and physicians is that which identifies it by its most important condition—the condition, namely, of organization.*

By this word we understand not merely the building-up of tissues, but also the development of forces according to a certain type; and, by the term organism, we imply not merely the material structure, but the sum of all the elements, material and dynamic, which do actually compose the living creature. The development of *excessive* force (*e.g.*, excessive heat) in any part of the organism indicates, not a local exaltation of life, but the escape of a portion of the tissues from the true bond of vitality or organization. Whatever, then, will reduce this excess of action is as truly a "stimulus" as are those agents which have the power to set in motion vital functions which have been temporarily arrested.

There is nothing very novel in the above statements to one who has been accustomed to follow with any regularity the course of scientific inquiry. But it is a surprising fact that the logical consequences of these now familiar ideas seem never to be deduced, at any rate by the great majority of persons. Among those lacking deductions we must include the banishment from use of such expressions as "over stimulation." This phrase and all its equivalents are, in fact, unphilosophical and self-contradictory, and it is the purpose of this paper to explain briefly the true character of the actions which have received such names, and the distinctions which separate them from the effects of true stimulation.

Of the excessive functional movements which popular error has attributed to the effect of over-stimulation we may select two or three notorious cases. Let us take first the rapid action of the heart, which occurs in an acute inflammation of the lungs, for instance. Here the received idea is that of a too-potent stimulus goading on the organ of circulation to excessive rapidity of movement. But, in truth, all increased rapidity of the heart's action (beyond certain narrow limits) may be taken as a certain sign that some portion of the apparatus concerned in the movements of that organ has *lost its vital powers* in greater or less degree. It is a phenomenon which is doubtless produced by some impression analogous to that which, in certain forms of narcotic poisoning, produces excessive hurry of the circulation immediately before its complete arrest. In fact, a certain degree of depression of the vitality of the nervous apparatus connected with the heart, if it be brought about with sufficient and not too much rapidity, will always greatly accelerate the heart's movements; and there can be no doubt that this is the origin of the rapid pulsations in acute disease. In these instances, the organ which is thus disturbed may be said to have *escaped from its vital conditions*, and to exhibit phenomena which, *pro tanto*, are physical rather than truly vital.

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* The word "Individuation," employed by Coleridge, is better than this; but in a popular treatise it may be better to avoid words which have a technical sound.

It is the same with the violent tetanic spasms which are caused by a poisonous dose of strychnia, and which are so often spoken of as the result of excessive stimulation or iritation of the spinal cord. Such effects as these are naturally but erroneously conceived of as directly opposed, in their physiological significance, to paralysis. In truth, however, there is no ground for this theoretical opposition of the two groups of symptoms; both the one and the other imply the death, temporary or permanent, of a certain portion of the nervous system. It is because strychnia *kills* the nervous centres of the spinal cord with great swiftness, that it produces general tetanic spasm; and the proof that there is no real opposition between the causal conditions of tetanus and of palsy, respectively, is found in the fact that an agent apparently so different from strychnia as opium may be made to produce precisely the same symptoms if it be administered to an animal, like the frog, in which the spinal cord is at once largely developed in proportion to the rest of the nervous system, and highly impressible, that is to say, delicate and feeble in its organization. The tetanized muscles may be said to have escaped, in great measure, from the control of true vital conditions, and the application of such a term as "excessive stimulation" to the cause of their movements is not merely incorrect but the extreme of incorrectness.

It would be easy to give instances of the error which we are considering in respect of excessive movements of any of the bodily organs; but I shall content myself with one more illustration. The abnormal action of the brain in drunkenness is often spoken of as an effect of over-stimulation. It is, however, not difficult to perceive, on analyzing the symptoms, that every one of them is really an evidence of paralysis. The noisy "roaring drunkard" is not troubled with any superfluous amount of brain-power, but with a partial brain-*palsy*: a palsy which has invaded those portions of the cerebral mass which execute the behests of intellect, prudence, and the moral sense, and has thus simply removed the checks ordinarily imposed upon the emotions and appetites. The flushed face, suffused eyes, and slightly thickened speech, give abundant evidence that this advancing palsy is pressing upon certain other portions also of the nervous system, and the staggering gait is another confirmation of this fact. Schiller tells us that wine *invents* nothing, but only *reveals* things; and the truth is, that the drunkard is noisy, lachrymose, sentimental, &c., just in accordance with the natural ground-work of his individual character, when the paralysis of moral sense and prudence permits this to appear. It is absurd, then, to speak of the unsteady, though violent, flickerings of the drunkard's mental energy as a case of "over-stimulation."

If the reader will follow up for himself the train of reasoning suggested by the illustrations which I have given, he will perceive that there is an absolute necessity for some definite change in our phraseology. The phenomena hitherto expressed by the phrase, "effects of over-stimulation," must receive some new name or names; and we shall be in a better position to appreciate the principles of the new nomenclature when we have defined the genuine effects of stimulation.

True stimuli produce effects which may be ranked under one or other of the following groups,—1. Relief of pain; 2. Arrest of muscular convulsion, tremor, and spasm; 3. Removal of delirium, maniacal excitement, and coma, and production of natural sleep; 4. Reduction of excessive secretion; 5. Relief of fatigue and disability of the organism in general, or of the brain or some other organ in particular; 6. Reduction of a too-rapid circulation; 7. Compensation for the absence of supplies of the materials usually called food; 8. Increase of local nutrition *where this is deficient.*

I am not going to detail here the numerous proofs, from modern clinical and physiological observation, which attest that the above are the true functions of stimuli, as I have already done that at length in another place; it is enough to say, that any observant practitioner will be able, on reflection, to endorse them from his own experience. What I desire to call attention to is this, that these effects can only be produced by any physiological agent, *when it is given in moderate dose.* For every single remedy there is a limit, beyond which it ceases altogether to produce its stimulant effect, and becomes active in an *entirely different sense.* The line may fluctuate (just as does the line of normal alimentation, or feeding) in accordance with constitutional peculiarity, and very notably in accordance with the existing state of health; but a line there nevertheless is, in every case, beyond which the medicine or food becomes a *poison.* With regard to the articles which in common parlance we call food and to some other substances allied to them, this limit is not reached except by the administration of a very enormous dose. But with regard to all other members of the Materia Medica it is to be noted that their administration in even a *slight* excess is immediately productive of one or more of the following decidedly poisonous effects: 1. Narcosis; 2. Inflammation of tissues (especially of the alimentary canal and of the glandular systems); 3. Serious alteration of particular secretions from their normal type. It is probable that the two last groups are really only varieties of the *narcotic* effect; that is to say, of an effect which paralyses especially the life of the nervous system, but which probably has also a direct lethal influence on the blood and on the tissues generally. Be this as it may, by far the most important of the evils inflicted by the excessive administration of substances, moderate doses of which act as stimuli, is the production of narcosis; and it is just this effect which results from excess in the use of some very familiar and important articles of daily consumption, and which unfortunately is constantly spoken of by the mischievous misnomer of "over-stimulation." In considering the action of stimuli, therefore, I shall confine myself to that group of these agents which in large doses exchange their stimulant for narcotic properties.

It would be a great mistake to suppose that the interest of the action of such substances as alcohol, chloroform, opium, tea, coffee, and tobacco, is only or chiefly for *professional* men. The strictly analogous principles which distinguish the physiological operation of them all are of a kind which it is really important for every one to understand; for there is a sort of impression abroad that, while tea and coffee are agents which we may afford to use carelessly, as having no very marked remedial effects, and no poisonous effects at all, the other substances which I have named are dangerous medicine poisons which we only admit to our ordinary dietary by a sort of compromise with our physiological conscience. It is precisely such mistakes as this which are rectified, with the happiest effect, as soon as we come to apply exact investigation. The simple observation of the comparative effects of *variations of dosage*, in the two cases, at once destroys the supposed distinction, and places all these agents on a physiological level. It demonstrates that, in moderate quantities, they are stimulant; in excess, narcotic—paralysing to the nervous system.

The sort of effect that is to be expected from the use of stimulant doses of any of these substances is indicated above, and the only one of the group which we are justified in employing in larger (that is, in narcotic) doses is chloroform. Owing to an admirable combination of qualities, by which this drug is at once very easily received into the blood through the lungs, and, on the other hand, very rapidly expelled again as soon as its temporary purpose has been fulfilled, we are able to employ chloroform so as to produce its truly poisonous effects (carrying these to a certain fixed limit, which is still at a safe distance from death) so as to render the patient completely insensible to the pain of the surgeon's knife. As the action of this anæsthetic presents a fair example of the general progress of narcosis when rapidly induced, it may be as well to describe the series of events which occur in an ordinary inhalation.

It is now fully proved that for safety it is quite necessary that such precautions shall be adopted as will ensure that the air breathed by the patient shall not contain more than 3·5 per cent. of chloroform vapour. These precautions having been taken, the inhalation is pursued with great regularity, the operator taking care to assure himself that the pulse keeps up its tone sufficiently, and that the face and lips do not become blanched. The patient usually exhibits one mark of apprehensive nervousness very strongly, namely, an abnormal quickness of breathing altogether out of proportion to the pulse rate, and owing, doubtless, to his attention being nervously directed to the respiratory organs. This abnormal quickness of breathing is greatly diminished by the stimulant effect which the chloroform exerts during the short initial period in which as yet only a minute quantity has entered the blood. As soon as true narcosis commences the pulse rises in frequency; simultaneously with this the intellect begins to be disturbed, the patient loses (or only retains feebly) the sense of present things, while occasionally (the restraint of prudence and morality being removed by the commencing brain-palsy) he becomes violent or indecent in his talk; at the same time that palsy of the tongue begins to interfere with articulation. Meantime, although from the patient's recumbent posture this has not been perceived by the bystander, palsy of sensation and motion has commenced in the lower limbs, and now proceeds to invade the upper, and the patient may sink quietly into general muscular and sensory paralysis and profound unconsciousness. But often the last remnants of mental action display themselves in an explosion of passion which causes more or less powerful voluntary struggles on the part of the patient; and, even after voluntary action has ceased, the advancing narcosis may, and not unfrequently does, produce spasmodic rigidity of the muscles, and, occasionally, epileptiform convulsion; all which "phenomena of excitement," as they have been absurdly called, are really the direct (though not the inevitable) consequence of the advancing nervous paralysis. The pupil, in the lesser degrees of narcosis, is contracted; but if the process is carried to a profound degree, as is necessary in operations on very sensitive parts (like the toenail-matrix, for instance), wide *dilatation* of the pupil ensues. In this stage the breathing is of a snorting character, and both it and the pulse are below the normal level of health. Flushing of the features and congestion of the eyes always occurs to a greater or less extent, and shows the existence of paralysis of the nerves which govern the vessels of the face and cranium; but of course this symptom is greatly aggravated when muscular struggles occur by purely mechanical means. Unless when a very profound degree of narcosis is required, a skilful operator will time the process of inducing anæsthesia very nearly to the period of four minutes in the great majority of cases. It may be effected much more rapidly, but irregular phenomena are then more apt to occur, and it is not so easy to keep such a check on the strength of the inspired vapour as will make fatal accidents (*as they ought to be*) impossible.

The above description will give a pretty good idea of the regular and consecutive way in which easily "diffusible" narcotics paralyse the various portions of the nervous system, and of the sort of signs which indicate the commencement and progress of the poisoning. With alcohol the case differs slightly; flushing of the features nearly always precedes the occurrence of intellectual confusion and thickened speech, and might be taken as a warning. A symptom which, in the case of chloroform, is not very easy of appreciation; viz., partial numbness of the lips, owing to paralysis of sensory branches of the fifth nerve, occurs quite early in alcohol-narcosis. The rest of this process is strictly analogous to that induced by chloroform, except that it is less rapid of course; and that involuntary convulsion very rarely occurs. It ends, if carried far enough, like chloroform-narcosis (*slowly continued for a very long while*) in death, by cessation of the *respiratory* movements; but if (what actually does occur in fatal accidents to human beings surgically operated on under chloroform) a very large dose be *suddenly* thrown into the circulation, it falls on the *heart*, and may paralyse it at once, though in the case of alcohol this is rare.

The action of opium has been more misunderstood and misrepresented, perhaps, than that of any drug in the Pharmacopœia. It has been taken for granted by the majority of writers that the characteristic effect of this substance, the effect in virtue of which it proves medicinal, is a depressing one. Those, however, who have had the largest experience of its action under a variety of circumstances will at once agree that every desirable medicinal effect which can be obtained from it is of a purely stimulant kind. It is precisely when the action of the drug produces no languor or depression whatever that its usefulness is the most decided. What we desire to produce by opium, in the case of a patient racked by pain, or unable to sleep from any cause, is not by any means a palsy of sensitive nerves such as shall render them unable to express to the mind the idea of pain; or a palsy of the brain such as shall incapacitate it from supporting the functions proper to its fully conscious state. In each of these cases we desire a stimulant effect; we desire that the nerves may be replaced in their normal condition of healthy vigour, so that they may cease to utter the cry of distress; or that the brain may be restored to the natural state in which sleep is the inevitable consequence of a certain amount of previous fatigue. In neither case does the opiate perform the duty of annihilating some positive *materies morbi*; it simply supplies a missing influence necessary to the bodily harmony. The rest is nature's own work. *Excessive* doses of opium produce palsy of sense, of motion, of consciousness, or, in creatures of weakly developed nervous system (as human infants, dogs, cats, and still more in some reptiles), convulsions of an epileptic or even tetanic character.

The soothing and restorative action of tobacco, which is enjoyed by the smoker who is sufficiently experienced to have overcome the first purely mechanical difficulties of the act, are familiar enough. The narcotic effects of an over-dose fall first upon that portion of the nervous system which is connected with the stomach; and, as the first effect of their paralysing action, induce nausea, and sometimes vomiting. A more powerful narcotic effect tends to paralyse the sympathetic nervous system generally, and more especially that part of it which is concerned in the action of the heart; and there is grave danger of actual paralysis of the latter organ, an accident which has occurred many times as a consequence of the pernicious practice of smoking a number of cigarettes in succession and inhaling all the smoke into the lungs, the result of which is to introduce a very large quantity of the poison into the circulation. Cold perspiration, and failure or intermittence of the pulse, are not merely disagreeable, but really very serious, symptoms of tobacco-*poisoning*, and should be met by the instant use of cold water affusion and the administration of ammonia or brandy.

Now tea and coffee are just as capable, when given in excess, of producing narcosis as are the above mentioned agents, although the evidences of paralysing action are not so obvious. The excessive or untimely use of tea, especially of green tea, is well known to produce a restlessness which precludes the advent of sleep. This condition is, in fact, a *narcotic delirium*, analogous to the condition induced in many opium eaters by a debauch with that narcotic, and which has been described by De Quincey and others. The true remedy for it is the administration of a little hot soup and a glass of wine, or a dose of sal-volatile. Often repeated excesses with tea produce a chronic dyspepsia, which is the result of a real and very permanent paralysis of the nerves of the stomach, and a general muscular tremor which indicates that the motor nervous system has not escaped. An over-dose of coffee produces nearly always a palpitation of the heart, which is due to partial palsy of its co-ordinating nerves; and *chronic* excess in the use of this beverage is apt to render this symptom an extremely frequent visitor, and to establish likewise a state of muscular tremor similar to that caused by habitual excess with tea or with tobacco.

The reader who has followed me carefully must have acquired a very different view of the action of stimuli from the popular one referred to in the opening words of this paper. It follows from what I have said that *common food*, provided it be easily digestible, is *the typical stimulant*, and this is really the case. There is no such curer of pain, sleeplessness, delirium, convulsion, &c., as concentrated soup or meat-jelly; that is to say, on the average, this remedy will succeed more frequently than opium, or wine, or ammonia, or chloroform, or any other stimulant—useful as these may be when confined to their really medicinal doses. It is in proportion as the latter remedies produce effects like those of food that they are successful in achieving any of these objects; and the supposed "recoil," which we so constantly hear of as the necessary after-consequence of stimulation, is, in fact, a pure myth. The symptoms of depression which have given rise to this notion are only produced by the impregnation of the blood with an *excessive* dose; when this has occurred, the symptoms are thenceforth those of narcosis only.

It is one of the laws of narcotic action that, in proportion to the frequency with which truly narcotic doses are repeated, a progressive increase in the quantity required to produce a given effect takes place. This is because the nervous system suffers a real physical lesion under the influence of each narcotic dose, and if time be not given before its repetition for nature to repair the mischief done, the evil *crescit eundo*. Less and less sensitive tissue remains to be acted on, and the blood must be more and more thoroughly poisoned to ensure the necessary contact of the poison with the nervous matter which is the seat of those processes which give rise to the sensual delights of the intemperate. To say this is at once to destroy the authority for the vulgar statement that the use of a daily stimulant involves a periodical increase of dose; a statement to which the habits of the millions of temperate indulgers in stimulants have always given a practical contradiction, and which is shown by the above considerations not to possess even a theoretical basis.

REVIEWS.

OUTLINES OF ASTRONOMY.*

A KNOWLEDGE of Science is gradually being acquired by the members of that very large community which is usually styled the general public. Greater advances have been made, however, in the departments of Chemistry and Biology, than in those branches of information which come under the denomination of the *exact sciences.* The latter invariably involve for their complete understanding an acquaintance with the higher mathematics, and these are too frequently a sealed book to the many. Of late years, however, much has been done in the direction of Astronomy, and now it is not uncommon to find amateurs who are not only conversant with the principles of Astronomy, but who have their own telescopic apparatus, and form independent opinions upon questions relating to their favourite subject. There can be very little doubt that much of the progress which has been effected is the result of the publication of such treatises as that which now lies upon our table, and on the part of the popular science world we here thank Sir John Herschell for all that he has done to forward the good work. The present volume is in its seventh edition, and with the exception of a few omissions, relating to recent spectroscopic researches, and the conclusions drawn by Tyndall and others, it may be fairly regarded as up to the time.

The author commences with an introduction, in which he cautions the reader against beginning the study of Astronomy with peculiar prejudices or dogmatic views. " He must loosen his hold on all crude and hastily adopted notions, and must strengthen himself by something of an effort and resolve, for the unprejudiced admission of any conclusion which shall appear to be supported by careful observation and logical argument." A piece of advice which is of considerable importance, and which applies to students of all other branches of science also. To attempt to analyse so copious a treatise as that before us would, considering the space at our command, be simply ridiculous. The great name and reputation of the writer, and the immense sale which the book has already attained, are sufficient guarantees for the accuracy and value of the " Outlines," as Sir John has modestly designated his voluminous essay. We may, however, state, that there are certain branches of the subject which have been very carefully treated, and which especially deserve perusal. For example we would commend to our readers' attention the chapter on comets, in which we find an advocacy of the view that "the structure of a comet, as seen in section in the direction of its length, must be that of a hollow envelope, of a parabolic form, enclosing near its vertex the nucleus and head." There, too, the writer states that "the luminous part of a comet is something in the nature of a smoke, fog, or cloud, suspended in a transparent atmosphere." The remarks on the curious subject of the perturbations of Uranus, and the discovery of the planet Neptune by Adams and Leverrier, are of intense interest, and demonstrate to those unfamiliar with the principles of the science, the exactitude of the basal scheme which constitutes the foundation of Astronomy.

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* " Outlines of Astronomy," by Sir JOHN F. W. HERSCHELL, Bart., K.H., M.A., D.C.L., &c. Seventh edition. Pp. 729. London: Longman & Co. 1864.

Sir John Herschell's work is illustrated by nine beautifully executed page-plates, which delineate the spots seen upon the sun and the willow-hand structure of the latter philosopher; Mars, Jupiter, and Saturn; the arrangement of the lunar mountains; one of the volcanoes of the moon, and various important comets and nebulæ. In point of style the writing is occasionally defaced by sentences of too prolonged a character, but in other respects the volume is an excellent one; and although we are far from thinking it is a book which may be placed in the hands of a mere beginner, still we believe that for those who have already acquired the rudiments of the science, no better treatise can be found.

MICROSCOPIC MANIPULATIONS.*

THE past twelvemonth has been extremely prolific in the production of works on the microscope, and the method of preparing objects for microscopic examination. All that have come under our notice have been good in their way. Some have been devoted exclusively to the mounting of objects; others to the characteristic structures of the tissues of plants and animals, when seen with the aid of microscopic apparatus. Now, however, a treatise presents itself, which combines all the student can possibly require in the shape of information necessary to make him a good working microscopist. Dr. Beale has done good service in publishing a new edition of his treatise, and whether we regard the product of his labours in this direction from a savan's, or a worker's point of view, we must confess it is an excellent one. The volume opens with descriptions of the simple and compound microscopes, and of the various pieces of apparatus which belong thereto. In this portion of the text we find the more useful instruments of English manufacture have been carefully described and compared, and that the author, without giving a decided preference to any particular microscope, evidently leans towards that of Messrs. Powell and Lealand. In the chapters on the examination of the tissues there is much valuable matter, which the student cannot acquire from other sources, and which betrays the very great practical experience of the writer. Dr. Beale describes how a structure may be investigated under all possible conditions; by reflected, transmitted, and polarized light, and how in adopting each of these methods, one may modify the result by the employment of various appended apparatus. In these paragraphs we observe that the relative merits of the *bull's-eye-condenser*, *metallic reflector*, *Lieberkühn*, *parabolic reflector*, *achromatic*, and *Gillet's condensers*, are impartially discussed, and much useful instruction is given relative to the methods of drawing an object. For the latter purpose Dr. Beale prefers what is called the tint glass reflector to the camera lucida, remarking that "the simplest and cheapest reflector for microscopical drawing consists of a small piece of plate glass, slightly coloured, in order to improve its reflecting power, but still not so dark as to prevent an object being seen through it perfectly. This is arranged at an angle of 45° with the eye-glass, and the draughtsman can very easily follow his pencil on the paper." There are some valuable hints given as to the mode of drawing upon wood and stone, and it is recommended that the student should learn the art of delineating with his own pencil the structures observed, for although "Mr. Tuffen West and one or two other gentlemen have taken up this kind of drawing and engraving, and have produced most beautiful results," yet no mere artist can make himself fully conversant with all the details of every branch of microscopic inquiry. On the subject of the measurement of objects Dr. Beale states his opinion that the most simple and efficacious method of ascertaining the size of specimens is by means of the stage micrometer and tint-glass reflector. The micrometer is first placed on the stage, and the instrument being arranged horizontally the scale is then, by the aid of the reflector, traced upon a sheet of paper, the object is then substituted for the micrometer, and the image being thrown on to the drawn scales, the measurement is easily achieved. Chapter III. contains an account of the different instruments required by the working microscopist, and under this head may be found concise descriptions of lamps, retort stands, tripods, brass-plates, and scalpels, Valentin's knives, scissors, needles, forceps, slides, cells, &c. Here also we perceive that the writer furnishes the character, and receipts for the preparation of the several liquids necessary in the operation of mounting or setting up specimens, such, for example, as gold size, shellac, asphalt, marine glue, Canada balsam, gum, French cement, glycerine, naphtha and creosote, naphtha and water, carbolic acid, chromic acid, preservative gelatine, gelatine and glycerine, gum and glycerine, Goadby's solution, Burnett's solution, solution of chloride of calcium, alum, arsenic, arsenuretted hydrogen, and nitrogen. In describing how to manufacture cells for one's own use the author gives the following useful information as to the perforation of thin glass :—

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* "How to Work with the Microscope," by LIONEL S. BEALE, M.B., F.R.S., Professor of Physiology in King's College, London, &c. Third edition. Pp. 272. London: Harrison, 1865.

"I cement a square or circle of thin glass with marine glue to one of the circular or quadrangular rings of glass, used for making deep glass cells ; the hole in the centre being the exact size of that required to be made in the thin glass. When the marine glue is cold, a file is forced through the centre of the thin glass. The cracks thus produced do not run across that portion of the glass cemented by the marine glue. The edges may then be filed square, and the thin glass only requires to be warmed in order to remove it from the cell. It may now be fixed upon the slide at once, or cleaned with potash, and kept with others until required to be made into a cell."

The chapter on the preparation of tissues and their injection is well worthy of attention. After enumerating the many forms of injecting fluids now in use, Dr. Beale declares his preference for the transparent liquids, carmine and Prussian blue, and advances no less than seven reasons for their employment, instead of the opaque varieties. The account of the mode of photographing objects is a lucid one; and the final chapter, relating to the use of very high magnifying powers and the nature of cell-life, will be found to contain all that the most recent discoveries have taught. No pains have been spared to make the book a valuable companion for the microscopist, and in addition to its other matter there are appended lists embracing the names of all microscope makers, English and foreign, preparers of objects, artists, wood engravers, printers, and lithographers, stone preparers, manufacturers of apparatus, and the titles of British and foreign treatises on the microscope, and English periodicals relating to the science of histology. The opening plate exhibits a series of well executed photographs of microscopic objects, which can be examined with the little biconvex lens with which each copy is provided. In all there are over fifty-six beautiful plates, and we can honestly affirm of Dr. Beale's treatise, that there is nothing relating to the microscope which is not discussed in its pages, and that it is a volume to be purchased by every working and amateur histologist.

STIMULANTS AND NARCOTICS.*

THE volume on this subject which Dr. Anstie has produced is one of remarkable interest to the general as well as to the professional reader. Ignoring the doctrine of a vital force and maintaining Coleridge's idea of life, that it is a tendency in a body to individuation, as the only peculiar and unvarying condition by which it can be described, he points out the nervous system to be the necessary requisite of individuation, as a mechanism by which a relation, most intimate and constant, between the parts united in the individual whole is upheld. "The standard of life," he goes on, "is a certain exact balance of various forces, developed with a certain *constant relation* to material tissue arranged *in a definite manner;* to say that we increase such life or 'vitality' in one part of the organism by destroying this balance, is a contradiction in terms. And the standard of function in an organ is the accurate discharge of such an amount and kind of work as may help to maintain this healthy adjustment of power and of matter in the organism; to say, then, that an organ exhibits an increased activity merely because it is seen to be under the influence of extraordinary powers, and to present a new arrangement of matter, is incorrect." To assume, then, according to the common doctrine, that all mental excitement, increased sensibility, pain, convulsive muscular action, considerable increase of secretion, and increase of the heart's action are caused by, and proofs of, a stimulant action upon the organism is erroneous. The cause of such effects must be a devitalizing action. And hence those agents which produce any of these effects, so far from possessing claims to be stimulants as they are usually considered, are rather devitalizing agents, or causes of loss of nervous power. Such agents must be described as narcotics. A stimulant being an agent having the power of exciting the action of the nervous system is determined by its effects tending, one and all, to restore the healthy standard of some vital process or processes. Such are Dr. Anstie's important views as to the nature of stimulants and narcotics, which he well supports by numerous illustrative facts and cogent reasonings. In the course of his argument he discusses the doctrine that stimulation is followed by a proportionate depression and denies that any depression at all follows true stimulation as a consequence of it. As a necessary conclusion from his views of the relation of stimulant and narcotic he also denies that the one or other effect being caused by the same medicine according to the dose in which it is given, is to be attributed to the one being an intensified form of the other as is commonly believed. But space does not permit us to dwell on these and other points ; nor on the interesting and valuable researches on the action of alcohol, ether, and chloroform, which form the latter part of the volume. Nor can we do more than refer to the history of the doctrine of stimulus and the extensive bibliographical references the work also contains, to the benefit of the student. The book, we may add, is published in a handsome form.

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* "Stimulants and Narcotics, their Mutual Relations." By FRANCIS E. ANSTIE, M.D., M.R.C.P., &c. London: Macmillan & Co. 1864.

AUTOBIOGRAPHY OF A PHILOSOPHER.*

THE principal exterminator of the organ-grinding race has supplied us with a very interesting and pleasingly-written account of his doings during a life-time spent in the attempt to advance science. Mr. Babbage is well known to the public as the inventor of that wonderful triumph of combined theoretical and practical knowledge, the "calculating machine ;" and to a history of the trials and expenses incurred in carrying the idea of constructing the machine to perfection, at least one-half of the volume now before us is devoted. Few will take up this work without expressing their surprise that human patience could have sustained so many defeats. The narrative of the years spent in carrying out his grand aim is a tale of the war between obstacles and perseverance, which is carried on whenever a great mind exerts itself to achieve a great end. It is almost marvellous to think how Mr. Babbage ever succeeded in giving substance to the profound scheme projected by his brain, and we conceive there are few cases in the annals of discovery which afford in so marked a manner a proof of the immense power of human energy when persistently brought to bear upon a complex and mighty problem.

It would be useless to endeavour—within these limits—to follow the author through his description of his interviews with Government on the question of his discovery, but we venture to assert that a more glaring instance of "circumlocutionism" has never yet been put on record. Year after year did he toil at his task, expending thousands in experimenting, always confident of final success but invariably opposed by difficulties. At length did Government expend a small sum in carrying on the work ; but the supply soon ceased and the then Chancellor of the Exchequer pronounced the project to be—

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* "Passages from the Life of a Philosopher." By CHARLES BABBAGE, Esq., M.A., F.R.S., &c. Pp. 496. London : Longman & Co. 1864.

1. Indefinitely expensive.
2. The ultimate success problematical.
3. The expenditure utterly incapable of being calculated.

In fact Government tried "How not to do it," and as far as it was concerned it succeeded. Now, however, the result proves the accuracy of Mr. Babbage's pre-conception, and fully justifies his bitterly sarcastic comments on the Tory Government. When speaking of the difference engine he writes :—

> "It can not only calculate the millions the ex-Chancellor of the Exchequer squandered, but it can deal with the smallest quantities; nay it feels even for zeros. It is as conscious as Lord Derby himself is, of the presence of a *negative quantity*, and it is not beyond the ken of either of them (the two machines ?) to foresee the existence of *impossible* ones."*

After the chapters devoted to the history of the calculating machine we are treated to a kind of *olla podrida*, containing descriptions of various incidents in the writer's life, and among the rest to those in connection with Mr. Babbage's pet grievance, the "street nuisances." Some—to us—amusing facts are stated, from which we learn that in one year this gentleman expended no less than *one hundred and four pounds* in his endeavours to suppress street music.

The "Passages from the Life of a Philosopher" can hardly be termed a scientific book, although it deals with many matters relating to science, and in one or two places is even hyper-mathematical. It is essentially a nicely and attractively written narrative of the principal incidents in a *savant's* life, and may be read by all classes of cultivated book-lovers, scientific and literary. Here and there throughout its pages many laughable anecdotes may be found, but above all things it shows what a single mind is capable of when pitted against circumstances, and justifies the remark of the author's mother: "My dear son, you have advanced far in the accomplishment of a great object, which is worthy of your ambition. You are capable of completing it. My advice is—pursue it even if it should oblige you to live on bread and cheese."

HEALTH SCIENCE.†

TO ameliorate the sanitary condition of the poor; to remove the working man from the foul purlieus in which he now drags on what can hardly be termed an existence; to develop a proper system of general drainage and ventilation: such are the serious tasks which the author of the important volume under notice proposes to accomplish. And how does he think he is likely to see so great an object attained? By publishing the results of his own numerous examinations of the dwellings of the poor. By showing us the filth and the misery and the depravity of the lower classes who inhabit the dens of London. Mr. Godwin is not a mere compiler or sensation-writer. He states facts. He exposes to our eyes what he has had the courage to look at with his own. If the picture be a ghastly one—if it depicts the life of men in cities as hardly removed from the life of the most loathsome beast it is possible to conceive of—the fault is none of the artist. Let it rather be ascribed to the advance of civilization, which has most certainly brought about the unhappy state of things which the philanthropic writer has revealed.

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* Impossible quantities in algebra are something like *mares' nests* in ordinary life.

† "Another Blow for Life." By GEORGE GODWIN, F.R.S., editor of *The Builder;* assisted by Mr. JOHN BROWN. With forty-one illustrations. Pp. 129. London: Allen & Co. 1864.

Wherever we follow Mr. Godwin in his rambles among the cellar and garret habitations of London, the same scene is presented to our gaze :—wretched apartments—prisons would be a less objectionable expression—devoid of light and air, damp to a degree of rottenness, and crammed with human beings. Adjacent sewers give off their noxious gases in large quantities ; foul cesspools accumulate beside the door-ways ; water is deficient ; and yet within the neighbouring tenements "God's own image" is driven to seek a residence. Can any language convey with sufficient force an adequate conception of the disgrace which such facts attach to those who have the means, but not the inclination, to establish a better condition of affairs ? If the atmosphere of one of our fashionable thoroughfares became tainted, even to the slightest extent, a thousand voices would be raised in outcry ; the Commissioners of Public Works would be called to account ; the great Jupiter of the press would declaim against the evil. Yet the whole amount of impurity, though slightly offensive to "gentle" nostrils, might be perfectly harmless in reality. But here, when the lives of thousands who constitute the thews and sinews of the population are in jeopardy, hardly one individual is found who has the courage to come forward and demand investigation. The poor labourer, even though he be all but suffocated by the pestilential vapours of some ill-constructed sewer, or deprived of even a minimum supply of water, has no *Times* in which to call attention to his grievance. No, he must suffer ; but certainly he cannot be expected, in a physical aspect, to "be strong" in addition. To such men, therefore, as Mr. Godwin the poor must ever be grateful; for, without a selfish motive, at much risk to their own lives, and at considerable pecuniary expense, they exert themselves to the utmost to benefit the condition of the labouring classes.

This book is a clever *exposé* of the sanitary, let us rather say, in-sanitary, state of our back-streets, lanes, and alleys, and is accompanied by numerous woodcuts illustrating the writer's views, and contains three important propositions relative to the improvement of the poor man's dwelling :—(1) There should be power to overlook houses let in tenements, and to enforce necessary improvements. (2) There should be power to prevent the letting of such houses to more persons than the amount of space will healthfully admit of. (3) There should be established ragged-schools, and means provided for the removal of youth of both sexes from situations which leave no hope. Mr. Godwin's volume is both interesting and profitable reading ; but it is rather of his mission than his writing that we would speak. He has undertaken a heavy labour, but one of which he may well feel proud ; he will have many difficulties to grapple with ; but let him not despair. His effort is a God-like one ; Heaven send it may prosper.

GEOLOGICAL TREATISES.*

IF Astronomy may be said to stand at the head of the series of philosophical branches of inquiry, assuredly Geology comes next in order of importance. This position is fully justified by the character of the science which deals with the past and present history of the globe on which we live. It is the office of the geologist to decipher that great "stone-book" of nature, in whose pages lie wondrous secrets as yet unrevealed to mortals. Hence there are very few departments of science whose field of observation is so vast, or whose natural laws are fraught with such serious interest as those of Geology. This may explain why so many are acquainted with its leading principles, and also why so many popular treatises appear upon the subject from time to time. As a rule, we hail with pleasure the appearance of a well-executed popular essay upon any branch of technical knowledge; but we feel disposed to accord special praise to the man who produces a useful and readable work upon matters relating to Geology.

The first of the treatises now under notice is written by no less a personage than the President of the Geological Society, and, as we might have expected from the author's high standing in the Geological world, it is as accurate in the information it contains as it is readable in point of literary composition. It is really a modified report of six lectures delivered to working-men in the Royal School of Mines in 1863. It opens with a chapter on denudation, and in this we are shown how constantly the forces of Nature are employed in breaking down old rock-formations and developing new ones. The mountain stream, as it rushes "from its rocky bed," brings with it the debris of the surrounding earth, these it pours into the stream, which in its turn passes them to the river, and finally they are brought down to the sea, and being deposited at the bottom, help to form new rocks, which in future ages will be found to contain traces of the animal and vegetable life of the present day. But this is not the only illustration of the effects of denudation which Professor Ramsay gives his readers. He shows that it is only by evoking the assistance of denudation that we can explain why certain deposits exist in a perfect condition in basins or valleys, whilst there is hardly a trace of them to be found on the adjoining mountains or hill-sides. Originally these deposits were formed all over the surface of the rocks composing the valley and mountain; but as the latter rose from the water, the new formation (let us say of coal, for example) became washed away, and that in the valley was left to tell the tale. Metamorphism is very lucidly explained. It consists in the change which a stratified or sedimentary rock undergoes when subject to intense heat and chemical action. The simplest kind of metamorphism is when an igneous rock is forced through or overflows a stratified rock, and remains for a long time in a melted state, the result of which is an alteration of the adjacent portions of the aqueous formation. Thus sandstone may, by such a process, be converted into quartz rock, which is no longer hewable, like ordinary sandstone, but breaks with a hard and splintering fracture. The writer concludes his remarks on this subject by expressing his opinion that granite is "simply the result of the extreme of metamorphism," and is not, as some geologists still maintain, of really igneous origin. That lake basins were originally scooped out by the operation of huge glaciers, is a doctrine to which Professor Ramsay seems also, and with much reason, to incline. This is a theory which has only been broached of late years, but which has the support of such men as Sir W. Logan, Dr. Newberry, Dr. Otto Torrel, Mr. Geikie, Professor Hind of Toronto, and many others. On the much-debated questions relating to bone caves, waste of sea-coast, raised beaches, and contemporaneity of man and the mammoth, the author's comments are most interesting and instructive. The volume which Professor Ramsay has presented to the public is illustrated by a small but exquisitely coloured geological map of Great Britain, and is got up in a manner highly creditable to its publisher. Altogether, it is an admirable little work, and we heartily commend it to our readers' attention.

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* "The Physical Geography and Geology of Great Britain." By A. C. RAMSAY, F.R.S., &c. Second edition. Pp. 199. London: Stanford. 1864.

"Advanced Text-book of Physical Geography." By DAVID PAGE, F.R.S.E., &c. Pp. 320. Edinburgh and London: Blackwood & Sons. 1864.

"Physical Geography for Schools and General Readers." By M. F. MAURY, LL.D., Commander in the Navy of the Confederate States of America. Pp. 141. London: Longman. 1864.

"The Physical History of the Earth." Meditations by A STUDENT. Pp. 134. London: Bagster. 1864.

Mr. Page's production relates rather to Physical Geography than to pure Geology; but is, of its kind, a useful and very well arranged treatise. With the student Mr. Page has ever been a favourite; for in his various contributions to scientific literature, he has left nothing undone to impress his ideas clearly upon the reader's mind, and by the aid of copious glossaries, notes, and recapitulatory chapters, he has cleared away many of those difficulties attending the study of science. The "Text-book of Physical Geography" does not form an exception to the rule. We observe throughout its pages a careful avoidance of that tendency to pile up dry facts, which is so common a feature of the style of certain writers. It is to the grand principles of the science that Mr. Page devotes himself, and, in our opinion, he has not done so to any disadvantage. The paragraphs are full of instructive matter agreeably conveyed, and it seems as though each chapter were complete in itself; for the reader can turn to any part of the volume and study profitably, although he has not begun his study systematically. In one or two instances we have noticed that the book is not as well "up to date" as it might have been; but the cases are of such trifling importance that they may very readily be forgiven, when we consider the valuable character of the other portions of the essay.

The author of the "Physical Geography of the Sea" has sent out a little treatise on Physical Geography, which may advantageously be placed in the hands of young beginners. It deals with the usual subjects embraced by the science of Physical Geography:—seas and ocean currents, rain and rivers, winds and tides, seasons and weather, &c. In most cases the writer has been very happy, both in his descriptions and illustrations; but in one or two places we find a good deal of clumsiness of expression, which we had scarcely anticipated. The chapter on the "Sea" is the best in the volume, and contains an account of an interesting experiment performed by the author to ascertain the way in which water freezes. Having taken a glass jar and filled it with sea water, he placed a thermometer and specific-gravity bottle in it, and exposed the whole to an open temperature of 23°. "As the thermometer in the jar fell, the specific-gravity bottle rose higher and higher, showing that the water, as it cooled, was contracting and becoming heavier and heavier. This went on till the thermometer marked 27°. Then commenced the display of the most exquisitely beautiful phenomena :—The fascicles of ice first formed at the bottom of the jar, and as fast as they formed they ascended to the top with great rapidity; in fact, it was a perfect snow-storm, only it was in miniature, and reversed." We are surprised to hear Dr. Maury speak of the coral-polypites as insects: such a state of zoological ignorance is hardly allowable now-a-days.

An individual who writes under the *nom de guerre* of "A Student," has investigated the relations between the Biblical and Geological accounts of the earth's history, and has arrived at certain pleasing conclusions. The author of the "Physical History of the Earth" was not only quite incompetent to undertake the task of writing upon Geology, but does not possess the faculty of impartially investigating evidence in order to arrive at truth. He argues for a foregone conclusion, and does so in such an imperfect manner that even those who are biassed toward his views would be likely, on reading his essay carefully, to form very different opinions from those which "A Student" endeavours to inculcate. The author's logic is only equalled by the utter insignificance of his production.

THE UTILIZATION OF MINUTE LIFE.*

SO much has been already written upon the above subject, that we hardly think there was any necessity for the publication of a new essay. Still, as Dr. Phipson has produced, all things considered, a very fair compilation, and his publisher has turned out a nicely-printed and handsome volume, we welcome the new book to the field of popular science. On glancing at the title, we expected to find the text devoted to the consideration of almost microscopic beings; but we find that by the terms "minute life," the writer intended to convey "invertebrate life;" for no rational being could think of calling a lobster or a coral-bed an example of diminutive existence. The aim of the work before us is to give an outline sketch of the natural history of those invertebrate creatures whose labours form a part of our industrial resources; and also to point out in what manner the population of various countries utilize the products of the beings so described. In the latter part of his double task, Dr. Phipson has been successful, and has brought together in a readable form much that concerns the cultivation of oysters, coral, leeches, silk-worms, *et hoc genus omne.* But in regard to the natural history of the various animals which have come under his consideration, his efforts have not been attended with such favourable results. To enter at length into this matter would occupy more space than we can command, so we shall confine ourselves to stating—in opposition to Dr. Phipson's allegations—1. That the phyllosoma is not the larva of the craw-fish. 2. That the production of neuter aphides is not to be explained on Dutrochet's views. 3. That the Echinodermata and Bryozoa do not belong to the division (?) Polyps. 4. That the class Rhozopoda is not higher than Infusoria. 5. That the gastropod and bivalve mollusca are not all hermaphrodite. Excepting those trifling errors which, after all, anyone not an original observer might easily be led into, Dr. Phipson's work is very carefully compiled, and will be profitably read by all who are interested in the subject of practical zoology.

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* "The Utilization of Minute Life; being Practical Studies on Insects, Crustacea, Mollusca, Worms, Polypes, Infusoria, and Sponges." By Dr. T. L. Phipson, F.C.S., &c. Pp. 282. London: Groombridge & Co. 1864.

SIGHT AND TOUCH.*

THE philosophy of vision is, whether considered as a physiological or a psychological subject, about one of the most obscure and difficult of all departments of science. It would therefore be beneficial to exact knowledge, that all questions relating to it should be fairly and impartially discussed. Whether Mr. Abbott has fulfilled these conditions, we shall not say, but at all events he has drawn attention to some very serious difficulties in the way of accepting Bishop Berkeley's theory of vision. It is necessary to explain to our readers the nature of the question at issue between the great bulk of physiologists and Mr. Abbott. How do we judge by the aid of the eye of the distance which any object is from us ? Present-day physiologists, acknowledging the accuracy of Berkeley's reasoning, say: by association with the ideas derived from our tactual or touch impressions of these same objects. That is to say, we look at an object, and in order to estimate its distance we make a mental and rapid comparison of its distinctness and illumination with those of some object whose exact existence we have ascertained by experience. Hence it follows, from this view, that in the first instance, in early life, a standard of length is framed by practice ; such, for example, as the time it requires, by means of bodily exertion, to reach some object, would enable us to institute. Similarly when conceiving of the form of a body, we contrast it with results which have been already derived from the exercise of the sense of touch. In proof of which latter, there are many instances on record of blind persons suddenly restoredt o sight, who were, for some time subsequent to the restoration of vision, compelled to judge of distance and form by touch, till they had sufficiently associated the sensations arising from the combined exercise of the two faculties. Now it is against this long-received doctrine, that our author has waged war ; and we think that although his pleading will hardly accomplish the result he aims at, there is nevertheless much force in his arguments, and a very considerable deal of erudition and careful study evidenced by his writing. He suggests that the eye has, independently of the other senses, the power of judging of distance by certain involuntary motions of its own. It is extremely difficult to make out clearly what it is that Mr. Abbott means ; for his style is characterized by a metaphysical tone, which would certainly engender in the careless reader's mind the notion that the author hardly understood what he was aiming at. This is very much to be regretted, as it tends to make the work unintelligible to the general public. If the author had clearly expressed his opinion, and followed his expression up by a categorical list of arguments in its favour, he would have done far more to advance his views than by writing a dozen treatises like the present. The statement of his theory, which we have given, is the only one which we think adapted to non-physiological readers. For the benefit of those specially interested in the question, we quote Mr. Abbott's own words, which, we confess, do not impress us satisfactorily. Speaking, as we take it, of the perception of distance, he goes on to observe :—

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* "Sight and Touch ; or, an Attempt to disprove the received (or Berkeleian) Theory of Vision." By THOMAS K. ABBOTT, M.D., F.T.C.D., &c. Pp. 178. London : Longman & Co. 1864.

> "We have found that the conditions of the perception in question, its range, errors, and perfection, correspond, with the utmost accuracy, with the laws and conditions of certain unfelt and involuntary motions in the eye, which have been shown to be determined exclusively by visual sensations. What these sensations are we cannot indeed affirm positively, but we know that in their case there can be no question of association, since when an object is distinctly seen and attended to, they have already produced their effect as regards that object, and have ceased to be."

We think Mr. Abbott might have been a little more explicit; for it certainly requires no mean powers of concentration to associate the ideas developed by the foregoing passages.

ORGANIC PHILOSOPHY.*

WHEN Mr. Lillyvick's barber declined to shave the chimney-sweep, although, according to the declaration of that worthy, he had been accustomed to perform that useful office for the baker, he intimated the necessity for a standard in all branches of life, by observing, "We must draw the line somewheres." We are impressed forcibly with the truth of this maxim, and, without desiring to institute invidious comparisons, we would merely observe that our line is drawn very far above works like the present one. We frequently find American books with loud-sounding titles, and whose letterpress is in the main composed of newly-coined terms, but in which there is very little philosophy after all. We do not often meet the like in England; but Dr. Doherty's treatise is an admirable specimen of the class of literature we refer to; that is to say, it is an excellent instance of a very worthless description of book. It is, above all, an ambitious volume, for, if we have understood it rightly (no easy thing to accomplish), its aim is to expose a grand code of laws which govern the phenomena appertaining to every known branch of science. In our humility, we had imagined that such an exposition was beyond the grasp of any individual human being, or that, at all events, if attempted, it should be by one whose connection with science proved him to possess some capacity for the task. It seems we were mistaken; Dr. Doherty, a gentleman whose name we certainly have never seen associated with any scientific results, has undertaken the labour of explaining all the phenomena which our universe presents.

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* "Organic Philosophy, or Man's true place in Nature." Vol. I., Epicosmology. By HUGH DOHERTY, M.D. Pp. 339. London: Trübner & Co. 1864.

Far be it from us to endeavour to follow him through the mystic and extraordinary process of reasoning which he has adopted. The mental exertion requisite for such an undertaking would be far beyond our poor allotment of brain-power. We must therefore relinquish the experiment to those of our readers who are possessed of the necessary amount of courage. The book may be really a clever one; indeed, our scepticism as to our own abilities to appreciate it leads us to think that it must be a very valuable and important production; but to our unassisted observation it is an embodiment of that much-hackneyed quotation, "*Vox et præterea nihil.*"

The author has not confined himself to the study of natural objects, as the following selected passages from his treatise will adequately prove:—"*In the body, we have a complex organism of physiorganic and industrial forces, faculties, or organs; in the soul, we have a complex organism of physiinstinctual and artistic forces and faculties; in the mind, a complex organism of physiomental and scientific forces and faculties; in the spirit, a complex organism of physiomoral and social passions and emotions. Not four unities, but one unity, in four different aspects of life; four partially discreet organisms in one atomic indivisible molecule or integrality.*"

A very excitable reviewer might feel inclined to comment severely on the above passage. Our disposition is exceedingly mild and gentle; so the small amount of irritation it has generated may be expended in the following quotation,—

'*Pol.* What read you, my Lord?
Ham. Words; words; words;
Pol. But the matter, my Lord?"

THE CHEMICAL PROCESSES OF THE PHARMACOPŒIA.*

THIS is an excellent little book, containing clearly-stated and accurate explanations of the various processes described in the Pharmacopœia for the preparation of medicines. It has been written by a gentleman who is, we believe, himself practically conversant with all the reactions described in his volume, and we must candidly confess, that from what we have read of it, it appears to us to be the most lucid and, at the same time, the tersest and most useful companion for the practical pharmaceutist.

VALUE OF WROUGHT IRON.†

IN this work the distinguished author advocates very strongly the employment of wrought-iron beams instead of the cumbersome materials of cast iron now in general use. He has brought both practical and mathematical arguments to his aid, and by the assistance also of a number of very well-executed engravings, has pleaded his case so well that we fancy there are few engineers who will not bring in a verdict in his favour. Not the least interesting portion of Mr. Fairbairn's important work is the description of the magnificent establishment at Saltaire, which, as the writer well observes, does honour to its owner, and has been a source of pride to himself, as being the important undertaking with which he terminated the active services of his *professional* life. This work will be found most useful to all engaged in building, and should be in the hands of every architect and engineer.

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* "The Chemical Processes of the British Pharmacopœia," &c. By HENRY J. CHURCH, M.P.S. London: Hardwicke. 1864.

† "Researches on the Application of Cast and Wrought Iron to Building Purposes." By W. FAIRBAIRN, C.E., F.R.S., &c. Third edition. London: Longman & Co. 1864.

OUR COMMON INSECTS.*

WHEN first we glanced at Mrs. Cox's little *brochure*, we anticipated having to be rather severe on the authoress, for we observed that under the title of a work on insects there were included descriptions of several of the *Arachnida*. On giving the book, however, a careful perusal, we found that the writer has disclaimed any such association of the two classes as scientifically accurate. In the definition which she has given of an insect, her ideas of the group are shown to be strictly correct; she merely alludes to the spider tribe to show that they are devoid of wings and provided with a cephalo-thorax and eight bags, and hence cannot be referred to the division *Insecta*. Mrs. Cox's style is clear, and withal simple, and, as a *very elementary* work on entomology, we can conscientiously recommend it.

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* "Our Common Insects. First Steps to Entomology." By MRS. E. W. COX. Fcap. 8vo. pp. 120. London: Hardwicke. 1864.

SCIENTIFIC SUMMARY.

ASTRONOMY.

New Planet.—In the last summary it was stated that Mr. Pogson had detected a small planet, which he erroneously supposed to be a new one, but which was subsequently found to be Freia. This error, however, he has since made good by the discovery of one which is certainly and evidently new. It was first seen (at Madras) on May 2, and has received the name of Sappho, which was given to his former discovery.

Transit of Venus of Dec. 6, 1882.—At the last meeting of the Astronomical Society, the Astronomer Royal examined in great detail the stations at which it will be most advantageous to observe the above phenomenon, now more important than ever from the doubts lately thrown on the sun's distance. These two stations, in order that the distance required may be deduced with the greatest certainty, must be so situated that at one the planet will remain for the shortest space of time on the sun's disc, and at the other the longest. For the former, the choice of stations is sufficiently extensive, reaching along the sea-board of the United States of America, as far down as the Gulf of Mexico. At that part of the globe, however, at which the time of transit will be greatest, and where the planet will be seen on the disc of the sun for nearly six hours, the choice of stations is more restricted, the most advantageous spot being at 65 degrees south, and at seven hours of east longitude. Near this place is situated Sabrina Land (discovered in 1839), and of which very little is known. Professor Airy proposes that a reconnaissance should be made of a point so important to the success of the expedition, and the following points determined :—(1) Whether the coast is accessible on Dec. 6. (2) Whether a latitude of 65 degrees can be reached. (3) Whether the sun can be well seen at that time of the year at three hours on each side of the lower meridian. Should the answers be unfavourable, it will then be advisable to examine other stations not very far different from five hours west longitude, with the highest possible south latitude.

Sun-spot Period.—Professor Wolf in addition to the well-known period of 11,2 years for the maxima and minima of the solar spots, has found from the records of those and Auroræ, that a more marked period occurs at every fifth of those epochs, and which had its last maximum in 1836. Mr. Carrington suspects that there may be some connexion between the distance of Jupiter from the Sun and the development of the spots, so that when that planet is farthest, there are more spots. Mr. Balfour Stewart has recently applied the same theory to those times at which both Jupiter and Saturn are at their shortest distances and in the same line, when he thinks that there should be a remarkable development of spots. He finds that

Saturn came nearest to the sun in August, 1841, and Jupiter in February, 1839, and also that they were closer about that period than at the previous and following aphelion of Saturn. As two revolutions of Saturn are equal to nearly five of Jupiter, it would follow that the same phenomenon would occur every fifty-nine years, which he thinks agrees very well with Professor Wolf's period of fifty-six years, and that the epoch of 1840 is not far distant from 1836, as found by him.

Transit Observations.—Mr. Dunkin has made an interesting comparison of the accuracy of the old method of observing the passages of stars as effected by the eye and ear, and the modern one in use at the Greenwich Observatory, in which the observation is recorded by the galvanic or chronographic method. He finds that by the latter method the minute fractions of time by which the most practised observers differ from each other is very constant, whilst by the former it was variable; the difference between two observers who had been engaged together for many years, varying from one-third to two-thirds of a second in the course of seven years. He finds that the probable error of a transit by the old plan 0·029 seconds, whilst with the new it is only 0·017 seconds. With the former it would appear, that with slow-moving stars the accuracy of the observer's judgment decreased, whilst it remained constant with the latter. The probable error of the right ascension of a star was 0·048 seconds by the eye and ear, and 0·034 seconds by the eye and touch. The smallness of those errors may be imagined, as Mr. Pritchard observed, by placing a human hair at a distance of 125 feet, when its thickness would be 0·022 seconds of time. The cause of the discordance between observers with the galvanic method lies in the fact that the finger may move a little too soon or too late on the tappet, and imperfect galvanic contact take place. Professor Wheatstone proposes that this should be remedied by a moveable wire following the star as it crossed the field, and when it came in contact with the fixed ones that the chronographic contact would be made, and thus a number of records obtained independent of the will of the observer. A method similar to this was employed by Mr. De la Rue in his lunar-photographic experiments. According to Colonel Strange, the suggestion of Professor Wheatstone has already been carried into effect by M. Redier, at the Paris Observatory, with perfect success, the wire being carried across the field so steadily and so exactly, with the same velocity as the passage of the star, that the intersection was perfectly certain. It would appear that the French astronomers are, however, somewhat favourable to the old system, although not so far as to exclude the new method, M. Le Verrier believing "that a touch observer does not acquire the same appreciation of duration of time as an observer trained to eye and ear observations."

Nebula of Orion.—It having been noticed by the Greenwich observers that the drawing of this nebula, as given by Sir J. Herschel in 1836, was more accurate than that lately published by Professor Bond, the latter celebrated observer examines this statement, and points out the discrepancies in detail between the two drawings, in which he considers his own to be the more correct. In Herschel's delineation he points out the following discrepancies:—(1) The absence of a definite limit to the bright light of the Huygenian region on its eastern side, close to the southern shore of the *Sinus Magnus*, and its consequent extension along this shore to a distance of

180 seconds beyond its proper terminus. (2) The bright light on the southern shore is carried ten to fifteen seconds too far north. (3) Of the four prominences on this shore, only one can be certainly recognized in the positions given. (4) In the best defined part, the western shore is placed twelve seconds too far to the west. (5) The bright spot in the *Pons Schroeteri* is too far north, and the bridge itself terminates without crossing the gulf. (6) All the features of the northern shore to the east of the *Pons Schroeteri* have been represented north of their true locality, at the same time that the direction of the principal lines is largely in error. From the remarkable changes which have been observed in the nebula of *Eta Argûs* it may not be impossible that the above discrepancies are not errors of observation, but real variations, which may have occurred during the last thirty years. It is highly important that those discrepancies should be noticed and settled at once, so that, should further changes take place in the same direction, astronomers may have reliable data in respect to those minute details.

Autographs of the Sun.—Professor Selwyn submitted a collection of collodion sun-pictures to the Astronomical Society, taken at Ely in 1863–4, some of which were 6⅝ inches in diameter. Mr. Stewart had noticed in the sun-pictures taken with the Kew Heliograph, that the faculæ belonging to a spot almost always appeared to the left of that spot, the motion due to the sun's rotation being across the picture from left to right; but Professor Selwyn has not confirmed this, but believes that the faculæ surrounded the spots equally. Professor Secchi, at Rome, has observed clear indications of the whirling action of the spots similar to the cyclones of the earth, and Professor Selwyn points the attention of observers to the importance of this question, and whether the whirling of the spots was in an opposite direction in the two opposite hemispheres, *i.e. contrary* to the hands of a watch in the northern, and with them in the southern, as has been observed on the earth. In the year 1863 Schwabe counted 124 groups of spots. Mr. Howlett noticed some remarkable changes in a spot on January 25th, which he saw actually take place whilst his eye was at the telescope.

Meteors.—Mr. Herschel, in a paper on the state of meteoric science, has given a new theory respecting the frequency of shooting stars, when the earth is moving from aphelion to perihelion, and their rarity in the opposite direction. This difference is very considerable, as Dr. Schmidt finds that on an average of 470 meteors which are seen annually at Athens, 400 are observed during the last six months of the year, and 70 during the first half. The minimum takes place in February, when only 5 are seen, and the maximum in August, when 188 on an average were visible. Mr. Pritchard illustrates the principle of Mr. Herschel's theory by supposing a flat umbrella at rest and rain falling on it from all directions, when the drops will be spread equally on its surface; but if it be carried forward, more drops will fall on its anterior than its posterior surface. So long, then, in a similar manner, as any particular horizon of the earth is going in the same direction as the earth's orbital motion, an additional number of meteors will be met with, the opposite point of the earth being comparatively sheltered. In northern latitudes, therefore, more meteors will be visible near the autumnal than at the vernal equinox. The case will be inverted in the southern hemisphere, and it is to be hoped that data will not be wanting in order to test the truth of this ingenious theory. It is founded on the principle, however, that meteors fall without preference from all directions; but from Mr. Greg's observations it would appear that there are ephemeral swarms of meteors which proceed from a common source. Mr. Herschel has calculated the relative number of meteors which should fall at any particular latitude, and finds that his theory agrees very exactly with observation. It is to be noticed, that not only ordinary shooting-stars but also fire-balls and ærolites and star-showers are more abundant in autumn than in spring, Mr. Greg, finding that the proportion of the first six months of the year to the last half being as 739 to 1,059. M. Quetelet finds that star-showers occur at the same periods in the proportion of 28 to 72.

Mu Herculis.—In 1856, Mr. Alvan Clark discovered the small star south preceding Mu Herculis to be a close double star, the distance being about two seconds. Mr. Dawes now finds that since that period it has changed in position, the variation amounting to eighteen degrees. As Struve ascertained, many years since, that Mu Herculis and the small star formed a binary system, it follows that it is now a triple system similar to that of Mu Böotis. Mr. Dawes remarks, that as the small star of Mu Herculis was observed by Struve so late as 1851 without its duplicity having been noticed, it would appear that the distance must have been considerably less at that time, although no variation has been noticed since 1857.

Bright Band seen on Moon's Border.—The cause of this phenomenon, which has been noticed in the photographs of solar eclipses, has been examined by the Astronomer Royal. He finds that when first looked at, it is seen rather conspicuously; when most distant from the eye, it appeared broadest; when brought suddenly near, it seemed to vanish, but, on looking carefully, it was found to exist, but much narrower than before. A piece of the thin black photographic paper was then cemented on the bright portion, but the same phenomenon was visible; from which Professor Airy thinks that it is an optical illusion, or nervous irritation of the retina, produced by the view of the conterminous black-and-white portions of the photograph.

Solar Eclipses.—Mr. Williams gives an interesting catalogue of solar eclipses, of which he finds accounts in the Chinese historical records. The present list extends from B.C. 481 to the Christian era. Although observations of comets are numerous, no lunar eclipses are mentioned.

New Telescope.—Dr. Steinheil has constructed a refracting telescope, of 4¼ inches aperture, and only 40 inches of focal length, of which Mr. De la Rue reports most favourably. He is now engaged upon one of 6 inches aperture, and the extraordinarily small focal length of 30 inches.

Double Stars.—Mr. Dawes publishes a list of fifteen very close double stars detected by him accidentally within the last twenty years.

AGRICULTURE.

Advantages of Artificial Manures.—The comparative merits of the artificial and natural manures have been demonstrated to French agriculturists by M. G. Villes, the superintendent of the Government experimental farm of Belle Eau. This gentleman gave the local farmers a series of lectures and demonstrations on the subject of manures. He showed them several fields of corn, treated with various artificial and natural manures, and some without any manure at all, and proved to them incontestably that the field fertilized with an artificial manure, containing the proper proportions of potash, lime, phosphates, &c., produced the best crops. We understand that the farm of Belle Eau, like that at Vincennes, has been placed at M. Ville's disposal by the Emperor.

Mr. Way on English Agriculture.—At the last meeting of the Chemical Society, Mr. Way read (or rather caused to be read) a paper, which was supposed to be upon the above subject, but was really an attack upon the doctrines of Baron Liebig. It is well known that of late years our agriculturists have begun to discover the truth of Liebig's theory, that ammonia is not to be regarded as a fertilizer, but rather as a stimulant, its main office when supplied in excess being the solution of certain of the mineral constituents of plant food. We presume, therefore, that this was the reason why Mr. Way's paper was contributed; for it contained nothing which he has not stated already *ad nauseam*, and it certainly was far from an impartial review of opinions which differ from his own. His answer to Liebig's assertion, that English farmers are exhausting the soil, was most obscure and unsatisfactory, and, so far as we could analyse it, seemed really to be an additional fact in support of the Baron's views. At the termination of Mr. Way's paper, Mr. Gilbert delivered a very vehement and lung-exhausting oration, in the course of which the facts (?) brought forward by him were repeated several times, and were strung together in the most unharmonious and illogical manner. His main argument was that the soil is not being exhausted, because the produce is greater than ever. By parity of reasoning, our coal fields are not being exhausted, because the supply of coal is more extensive than it was fifty years ago. Will no one present Mr. Gilbert with a copy of "Whately's Elements," or J. Stuart Mill's famous treatise?

BOTANY.

Peculiar mode of Conjugation among Navicular Diatomaceæ.—Mr. H. J. Carter points out the manner in which the process of conjugation occurs among the latter forms of diatomaceæ. The contents of the two conjugating frustules, after having passed into the usual spherical form of the sporangium, and then having undergone division into the two smaller spores, each of the latter becomes elongated, separates in the equatorial line, and each hemisphere being carried out upon the ends of the contained sporangial frustule-cases in a cap-like form, remains there, till these sporangial cases attain their maximum development. *Pari passu*, the large frustule is produced within all, and ultimately a longitudinal fissure extending throughout the frustule-case gives exit to it by this kind of dehiscence. Besides the three conjugations which have been described by other writers, Mr. Carter has observed a fourth, and he thinks it is possible to observe others also. In conclusion, he expresses his opinion that the object of these repeated conjugations is to bring the size of the frustule from its embryonic state up to that of its maximum development.—Vide *Journal of Botany*, September.

Structure of the Flower of Crucifers.—This is the subject of an important paper by Mr. W. G. Smith. There may be said to be four peculiar features in the arrangement of cruciferous flowers:—1st. The oblong plan of calyx. 2nd. The oblong plan of petals the reverse way to calyx. 3rd. Two sepals of the calyx higher on the stem than the other two. 4th. The curious receptacle on which the smaller stamens grow. The first peculiarity is explained thus: as the single stamens are farther removed from the ovary than the two pairs are, room must necessarily be made for the bases of these two stamens. The cause of the second arrangement is that these stamens are so far from the ovary, they push between the pairs of petals and so elongate the petal plan the other way. The third form is accounted for by the fact that the two odd stamens form a second whorl, which is lower on the receptacle than the pairs, and in this way push down two of the sepals. The strange receptacle which does not form a circle, is regarded by Mr. Smith as the remnant of one which typically forms a complete circle. He says, "In *Megacarpœa polyandra* there is a receptacle all round the bases of the stamens. Therefore, I suppose, normally in all cruciferæ there is a receptacle at the base of the second whorl, but as the second whorl of stamens is incomplete in nearly all the cruciferæ, the receptacle is incomplete also. I look, therefore, upon these appendages at the bases of the odd stamens as imperfect remains of a receptacle that should go all round, but is partially suppressed in the same manner as the stamens of the second whorl are suppressed."

Progress of the Royal Botanic Society.—At the anniversary meeting of this Society, (Professor Bentley in the chair,) the report read by the secretary, Mr. Sowerby, showed that the condition of the society is improving. The present number of fellows is 2,334, of whom 137 were elected during the past year. The receipts from all sources have been most satisfactory. The income was £10,781, and the expenditure £8,059. 7*s*.

Recent Fall of Manna in Asia Minor.—A letter from M. Haidinger to Sir Roderick Murchison, describing the appearance of a large quantity of manna lately (July 6th) observed near Diarberkir, was published some time since, and has created a good deal of controversy, regarding the nature of manna. We believe, however, that there can be very little doubt that it is a species of lichen which like a fungus springs up in the course of a single night, and thus gives rise to the notion that it has fallen from the skies. This manna is ground into flour and baked into bread, the Turkish name of it being *Kudert-bogh-dasi*, which means wonder-corn or grain. Though used as bread, its composition is remarkable; for it contains more than 65 per cent. of oxalate of lime, and has about 25 per cent. of amylaceous matter. This substance is evidently the manna of the Hebrews, who gave it the name of *Man-hu*, which signifies "what is it?" from the circumstances of its sudden appearance and their previous unfamiliarity with it.

Direction of the Leaves of the Compass Plant.—In the *American Journal of Science*, Mr. Hill gives the following account of his examination of the leaves of thirty specimens of this interesting plant, with a view to discover their exact meteorological bearings: Holding a card over each plant with its edge parallel to the central line of my own shadow, I marked upon the card a short line parallel to each leaf of the plant. Measuring afterwards the angle which each mark made with the edge of the card, and subtracting from each angle the azimuth of the sun for the estimated central time of observation, I obtained the following results:—Only one plant, bearing four old leaves, gave an average angle with the meridian of more than 34°. Their mean was 18° west. The remaining 29 specimens bore ninety-one leaves, which made with the meridian the following angles, viz., seven made angles greater than 35°; fifteen, angles between 35° and 20°; sixteen, angles between 20° and 8°; twenty-eight, angles between 8° and 1°; and twenty-five, angles less than 1°. Of the sixty-nine angles less than twenty degrees, the mean is about half a degree east of the meridian. The error of azimuth, from my want of means to determine the time accurately, may have been as much as three times this quantity. One half the leaves bear within about half a point of north; two-thirds within a point. The magnetic declination was about 6° east. The observations were made when the sun was about on the magnetic meridian.

Respiration of Flowers.—The conclusions which M. Cahours forms as the results of his late inquiries upon this subject may be thus stated:—

1st. All flowers confined within a limited atmosphere of ordinary air consume oxygen and develope carbonic acid, the proportions varying according as the plant has a perfume or has not.

2nd. *Cæteris paribus*, the greater the temperature the greater the amount of carbonic acid developed.

3rd. Generally, when the flowers have been collected from the same plant, and equal weights of them are exposed to light and darkness, the carbonic acid formed by those in the dark will be in larger quantities than that evolved by them in the light.

4th. When the ordinary air is replaced by oxygen the difference is more prominently marked.

5th. Flowers which are in process of development, give off more carbonic acid than those which are fully formed—a fact which is explained by reference to the greater amount of vital action going on in the one than in the other.

6th. Flowers exposed to the influence of an inert gas disengage small quantities of carbonic acid.

7th. Of the various parts which compose the flower, the pistil and stamens (being the structures which expend the greatest amount of force,) consume the greatest amount of oxygen and set free the largest quantity of carbonic acid.

Presence of Vegetable Spores in the Atmosphere.—In the course of the important discussion upon the subject of spontaneous generation, some very important facts have been elicited by the experiments of Dr. J. Lemaire, who has communicated the results of his investigations to the French Academy. The atmospheric vapour of several localities was collected, condensed, enclosed with a portion of ordinary air in sealed tubes, and then microscopically examined, and in every instance large quantities of vegetable and animal forms were observed. In one case the air and vapour were collected at Romainville, at a height of nearly 300 feet above the level of the Seine, in a locality of a most salubrious character. At the moment of condensation, the water contained, independently of small particles of dust and filaments of various sorts, a few ovoïd spores and a great many small semi-transparent bodies, which were seen in making other experiments also. Twenty-four hours after this, bi-jugated cells, bacteria, vibrions, and monads were observed. At the expiration of forty-eight hours the spores and cells had disappeared, the bacteria and vibrions became motionless, but the monads, which were then very numerous, were exceedingly active. From this period (July 29) to August, monads were the only things to be seen, and they were few in number. On comparing the air of Sologne, which is a marshy district, with that of Romainville, it was found that the former contained both microphytes and microzoa in much larger proportions than the latter. Associating this fact with the order of disappearance of the different forms of existence which he observed, Dr. Lemaire states that in his opinion "there is a similar state of things in both aërial and terrestrial worlds. The plants serve as food for the animalcules, when the former are consumed, then the smaller infusoria are eaten by the monads ; finally, the latter devour each other, the strongest alone surviving in virtue of the laws of the '*struggle for life.*' What confirms this view is the fact, that in the vapour collected at Sologne, which was rich in microphytes, the bacteria and vibrions lived for fifteen days, whilst in that collected at Romainville, in which there were few microphytes, they did not live for more than three." However interesting these researches of Dr. Lemaire may be, there is still the question, Do bacteria or vibrions belong to the animal kingdom ? Till this is answered, the latter portion of his conclusion must be received with considerable distrust.

Difference between Quercus Sessili-flora and Q. Pedunculata.—Some botanists are of opinion that the distinction between these two species of oak is more imaginary than real, but the study of the subject by Dr. Heinrich Möhl leads to an opposite inference. Moreover, as the structures upon which he bases his separation of the species are to be found whilst the plants are in leaf, an additional interest lends itself to the question. The bud of *Q. Sessili-flora*, says Dr. Möhl, tapers from below upwards, and is traversed by five well-marked longitudinal ridges. The bud scales are arranged in spiral cycles, the direction of which is very oblique, so that the successive scales of the same series only overlap one another to a slight extent at the base, but each scale covers over the lower half of the one placed immediately above it, in the adjacent cycle. The bud of *Q. Pedunculata*, on the other hand, is shorter, broadly ovate, less acutely pointed, its scales are strongly developed, and apparently irregularly distributed in four widely-separated spiral ranks, so that the half of each scale is uncovered, although the successive scales of the same series frequently overlap one another at the base to the extent of half their surface. The leaf affords even more definite characters, that of *Q. Sessili-flora* being lobed at the base, whilst that of *Q Pedunculata* is simply wavy.—Vide review of Dr. Möhl's *Morphologische Untersuchungen über die Eiche*, in *Journal of Botany* for July.

Gases exhaled by Fruits.—This is a subject which has not been so carefully considered as it deserves. M. Cahours, who has already investigated the respiration of leaves and flowers, has arrived at the conclusion that the green parts of plants are not the only structures which have the power of breathing. He has endeavoured to study (1) the proportion of gases contained in the parenchyma of the pericarp, and their composition ; (2) the action of fruit upon the pure oxygen and atmospheric air ; and (3) the action upon the same gases of each of the envelopes of the fruit, and that of the fleshy part also, when it exists. He finds that apples, oranges, and citrons, placed under bell-jars containing oxygen, or this gas mixed with nitrogen, consumed oxygen and evolved carbonic acid, the proportions being greater in diffused light than in darkness. Up to a certain point this takes place gradually, but beyond this, it increases to a considerable extent, and the internal surface of the pericarp exhibits certain alterations of structure. The greater the temperature, the larger will be the volume of carbonic acid exhaled. Nearly the same amount of carbonic acid is evolved during the two periods of approaching maturation and approaching decay. But once the latter stage has been arrived at, the quantity of exhaled carbonic acid increases rapidly. The proportions of gases contained in the juices were thus estimated :—The juice, having been expressed, was placed in vessels, and the gases expelled by ebullition. It was found in this way that carbonic acid and nitrogen are present in various proportions, but that none of the following exist in fruit juice :—Oxygen, hydrogen, carbonic-oxide, carburetted hydrogen. When ripe fruit is enclosed in an atmosphere of air it absorbs hydrogen with great rapidity, and if it is allowed to remain till it has become soft, it is found to contain a large proportion of gas rich in carbonic acid.

Connection between the Geographical Distribution and External Characters of Plants.—Some time ago Dr. Welwitsch, the celebrated African botanist, presented a memoir upon a remarkable species of *Cissus*, from the south of Benguella, in which, whilst describing *forty* distinct species of the family Ampelidæ, he showed that these plants were interesting to the plant geographer, as well as to the botanist. The forty species described by Dr. Welwitsch are spread over a space of 300 miles from east to west, commencing with the burning sandy steppes of the Atlantic coast region, and extending into the richly-wooded, cool, elevated plains of the interior. Throughout this space the number of species increases gradually, and the number of individuals becomes continually greater. It is found that the species with thick, sappy, fleshy stems preponderate in the littoral region, that is, within a height of 1,000 feet from the level of the sea ; those with elongated twining stems, in the regions of the primeval forests ; and the species with upright scarcely twining stems, in the highest regions of the elevated plains of the interior. Another characteristic accompanying the geographical distribution of the Angola species of *Cissus* is the hairy covering of the stem and leaves. The species of the littoral region, for the most part, exhibit bright green, and but slightly green stems and leaves, whilst the species of the primeval forest region are characterised by dark green shining foliage, and more or less leathery, sometimes even evergreen leaves. On the other hand, in almost all the species of the region of the elevated plains, a thick, hairy, or even felt-like covering is seen on the stem and leaves. In a species which occurs on the gneiss rocks of Pungo-Andongo, this latter covering forms such a thick golden-brown pile that the entire plant has the appearance of having been hewn out of pure copper, and is indisputably one of the most beautiful of the vegetable productions of Angola. This species Dr. Welwitsch has termed *Cissus Livingstoniana*, in honour of our distinguished fellow-countryman, Dr. Livingstone. —Vide *Proceedings of the Linnæan Society*, vol. viii., 1864.

CHEMISTRY.

Action of Light on Santonine.—Most of our readers are aware that santonine, which is a peculiar principle derived from plants of the composite order, becomes of a yellow colour when exposed to the influence of light, whether *in vacuo* or not. M. Sestini now appears in the field as an investigator of the properties of this compound, and he has made some very interesting discoveries. When the actinic rays are cut off by a solution of nitrate of uranium this peculiar change does not occur. Crystals of santonine, reduced to powder and exposed to light, not only change colour, but evolve a resinous odour, and acquire a very bitter taste. Water added to this altered santonine acquires a yellow colour, an acid re-action, and a bitter taste. If now the mixture be distilled, an acid liquid will be produced, which reduces nitrate of silver and bichloride of mercury, and throws down acetate of lead as a white precipitate. When the distillate is evaporated to dryness, it gives a deep red-coloured resinous residue. When the coloured santonine is treated with water it almost entirely loses its odour, and when then treated with alcohol, it is in great part dissolved, giving a yellowish solution, which, on evaporation, leaves a reddish yellow residue, most of which is soluble in ether. The etherial solution leaves an uncrystallizable deposit of an amber colour, and a very bitter taste. From various experiments M. Sestini concludes that, by exposure to solar light, santonine is changed into formic acid, and an uncrystallizable substance much more soluble in alcohol and ether than santonine itself, and also a red resinous substance. He has termed the yellow uncrystallizable substance, provisionally, *photo-santonic acid.*—Vide *Bulletin de la Soc. Chimique*, July, and *Chemical News*, Sept. 3.

Cholesterine an Alcohol.—This has recently been demonstrated by M. Lindenmeyer, who has succeeded in forming the ether, and who has also discovered this compound in considerable proportions in peas, beans, almonds, and other vegetable substances which contain much albumen.

New Method of determining Water in Organic Substances.—This has been devised by M. Winckler, and is founded upon the change of colour which takes place in anhydrous chloride of cobalt, when it absorbs water. Dry chloride of cobalt may be easily dissolved in alcohol (density 0·792) forming a beautiful blue solution, but when hydrated bodies are placed in this latter they give up their water, and the result of this is that the solution acquires a reddish hue. The operation is begun by ascertaining the quantity of water which is required to give a fixed weight of cobalt salt a certain red colour. M. Winckler states that he has found the process both practicable and efficacious.

A new Albumenoid substance in Milk has been discovered by two French chemists, MM. Millon and Commaille. It has hitherto been believed that casein is the only proteine compound in milk, but these chemists have shown that after this has been removed there remains a substance which possesses many, though not all of the characters of albumen. They precipitate the casein with acetic acid, and the filtrate, when heated, produces a coagulum which contains 15·6 per cent. of nitrogen. The new substance, which they propose to term *Lacto-proteine*, has the following characters :—It is not coagulated by heat, nor by nitric acid, nor by bichloride of mercury, nor even by the combined action of acetic acid and heat. It is but slightly affected by concentrated alcohol, but is readily precipitated by an acid solution of the nitrate of binoxide of mercury, the precipitate, however, re-dissolving in excess of the precipitant.

It has also been pointed out by these experimenters that the odorous principle of milk may readily be extracted by means of bisulphide of carbon, which does not dissolve the butter, but extracts the perfume of the milk, which they say is sometimes agreeable, sometimes not, according to the nature of the material upon which the animal has been fed. In reference to colour, they found that the butter of cow's milk is always yellow, but that of goats, sheep, asses, and the human female, is invariably white.—Vide *Comptes Rendus*, August 8 and 27.

How to detect Impurities in Alkaloids.—MM. de Vry and Alluard communicated some interesting facts relating to this question to a late meeting of the French Academy. Their experiments were principally made upon specimens of quinine, and consisted in the examination of polarized light, which had been allowed to traverse the crystals. On comparing in this way the best quinine of commerce with the pure alkaloid prepared by themselves, they found, as might have been anticipated, that the polariscope revealed the presence of impurities, when these were in too small proportions to be detected by chemical processes. The reason alleged for these inquiries is that MM. de Vry and Alluard had found M. Bouchardat's determinations to be erroneous.

Cause of the Coagulation of Albumen.—That this is rather a physical than a chemical process is the opinion of a rising Irish chemist, Mr. Emerson Reynolds of Dublin. It is well known that albuminous liquids containing a small amount of alkali are easily coagulated by heat; but if the quantity of alkali be increased, a point is arrived at where its influence physically appears to be lost. "If, then," writes Mr. Reynolds, "we regard a solution of pure albumen as being in a state of unstable equilibrium, capable of being upset by very slight physical causes, the addition of a minute trace of alkali tends to throw the balance on the side of permanent solution, for then mere agitation or friction is not able to overcome the influence of the alkali; but if we apply the more powerful physical agent (heat) the obstacle is easily surmounted, and the result is coagulation. Let us now go a step farther, and add a still larger proportion of alkali; we then find that even the highest temperature to which the mixture can be brought is insufficient to produce coagulation, owing probably to the intensity of the physical agent being too low to overcome the affinity between the acid and base. If, however, a neutral salt, such as nitrate of potassium or sulphate of sodium, be added, the boiling point is raised, the intensity of the physical force is increased proportionably, and the result again is coagulation."—Vide *Dublin Quarterly Journal of Science*, No. XV.

The Preparation of Aniline Green.—We believe we are correct in stating, that the first who observed the reaction which produces this beautiful tint was M. Eusebe. He found that when he dissolved crystallized aniline red in a mixture of alcohol with sulphuric, hydrochloric, or other acid, and added a certain quantity of wood spirit, an exquisite violet hue was produced; this quickly changed to blue, and then, on the addition of hyposulphite of soda, a lovely green colour was developed. This process, however, though important, as having orginated the discovery, has many serious disadvantages. The colour may readily be produced by the adoption of the following method: 150 grammes of crystallized sulphate of rosaniline are dissolved in 450 grammes of cold diluted sulphuric acid (3 parts of acid to 1 of water). When the solution is complete, 225 grammes of aldehyde are added, and the mixture is stirred. The whole is now heated in a water-bath. From time to time a drop of the mixture is taken up with a stirring-rod, dropped into acidulated water, and as soon as a deep green solution is obtained, the reaction is stopped. The mixture is now poured into thirty litres of boiling water, and to this solution is gradually added 450 grammes of hyposulphite of soda, dissolved in the smallest possible quantity of water. The whole is now boiled for some minutes. All the green remains in solution—it is a beautiful hue, and is especially so in artificial light, which serves to distinguish it from other shades of green, prepared from different materials. When in this condition the "aniline green" may be directly employed in the dyeing of silk and similar fabrics.—Vide *Artizan*, August, 1864.

Is Professor Graham the Discoverer of Dialysis ?—The following very important statement is contained in the Paris correspondence of the *Chemical News* (No. 248). It bears upon the claim to priority of discovery of dialysis, and we doubt not it will soon receive contradiction :—On April 1, 1854, M. Dubrunfant (whose writings are familiar to most readers of French scientific literature) took out a patent for certain improvements in sugar refining, in the specification of which he declares, first, that when water and molasses are placed in a vessel separated only by an animal membrane, a weak current is set up between the two liquids ; and, secondly, that the water carries with it the salts contained in the molasses, that by their presence they prevent the sugar from crystallizing. Graham's celebrated Bakerian lectures on the osmotic force, in which he first explained the dialytic action of membranes, were not delivered until June 15 of the same year. The patent was subsequently rendered useless by the discovery of the method of refining sugar by Baryta. M. Dubrunfant has, however, lately (June, 1863) patented a refining apparatus on the dialytic principle, in which the septa are made of parchmentized paper. An experimental apparatus has been fitted up at the refinery of Courrières, near Valenciennes. In this apparatus, not only are the salts separated by dialysis from the sugars, but the same means are adopted for separating the nitrate of potash which they contain from the other salts. The above statement would seem to imply that Professor Graham was not the first to announce the discovery ; but we have little doubt that there exists abundance of evidence to show that his discovery had been absolutely though not formally announced long before the 15th of June.

Soluble and Insoluble Digitaline.—Two forms of this alkaloid are prepared for sale : one comes from Germany and is soluble in water and alcohol, the other is manufactured in France, and is but sparingly soluble in water. The German variety is said to be made by Merck of Darmstadt. It is of a yellowish-white colour, neutral to test paper, and completely and readily soluble in both alcohol and water. It is, on the contrary, but slightly soluble in ether, sulphide of carbon, and benzole. It is entirely precipitated from its aqueous solution by tannin. When dropped in a state of powder into hydrochloric acid, it immediately dissolves, forming a yellow solution, which gradually turns brown, and finally becomes green. The latter colour, however, is not so bright as that produced by the unsoluble digitaline, although it remains transparent for a longer time. As the green colour is being developed the solution becomes turbid, and emits an odour resembling that of powdered digitalis or the tincture, and a brown substance, which seems to be a compound of digitaline, is deposited. This variety of digitaline turns brown when exposed to the fumes of hydrochloric acid, but shows no green colour. When viewed under the microscope with a high power, it is seen to consist of small semi-transparent fragments, which occasionally present sharp edges, but have nothing approaching to a definite crystalline arrangement.

The French digitaline, on the other hand, though exceedingly soluble in alcohol, is but sparingly so in water, a litre of which dissolves only 0·50 of a gramme. The colour varies from a yellowish-white to a bright yellow. This form of the alkaloid is slightly soluble in sulphuric ether, sulphide of carbon, and benzole, and is precipitated from its saturated aqueous solution by tannin. When exposed to the vapour of hydrochloric acid, it becomes first yellow, then brown, and finally green; thus showing a very different reaction from the soluble form. This difference in colour suffices at once to distinguish the two varieties, and it is even thought sufficient to demonstrate the presence of the French species.—Vide *Chemical News*, August 27.

Comparison between the Effects of Gun-cotton and Gunpowder.—It is quite true, as Mr. Scott Russell remarked, in his recent lectures at the *Royal Institution*, that there is considerable difficulty in comparing the properties of the two latter compounds. The cotton he considers to be sixfold stronger than the powder. Thus, if we take four ounces of gun-cotton, and if we bore a hole 3 feet deep and 1½ inches wide into hard rock or slate in a quarry, and place this quantity of cotton in it, and close the aperture in the usual manner; and if, in the next place, we fill a similar hole with 24 ounces of best gunpowder, and then explode both compounds, the 4 ounces of gun-cotton will do more work in splitting the rock than the 24 ounces of gunpowder. Gun-cotton is more convenient than powder, because it has not that power of heating the metal, which causes so much delay and danger in ordinary artillery practice. Again, there is no smoke; whereas, occasionally in artillery practice at sea the stratum of smoke is so dense that nothing can be seen from the ship. Besides, gun-cotton leaves no dirty deposit, and hence is devoid of that nasty quality which powder possesses of fouling the gun. It is not cheaper when compared pound for pound with powder; but such a comparison would be unfair, as it is by the relative quantities of the two substances required to produce a given result that we should estimate their comparative value. Mr. Russell gives the following very interesting illustration of the operation of both these compounds under the same conditions: If a general wants to blow open the gates of a city, he orders an enterprising party to steal up to the gate with a bag containing a hundred pounds of gunpowder, which he nails to the gate, and by a proper match-line he fires the gunpowder, and bursts open the gate. If he nailed a bag of gun-cotton of equal weight in the same place, and fired it, the gun-cotton would fail, and the gate would be uninjured, although the hundred pounds of gun-cotton are sixfold more powerful than the gunpowder. Here, then, gunpowder has the advantage, both weight and effect considered. But the fault here lies, not in the gun-cotton but in the way of using it. If, instead of a hundred pounds of gun-cotton in a bag, twenty-five pounds had been taken in a proper box made for the purpose, and simply laid down near the gate and not even nailed to it, this twenty-five pounds would shiver the gate into splinters. The bag, which suits the gunpowder, happens not to suit the gun-cotton.

A new Method of Estimating the Per-Centage of Astringent Matters in Plants is described by M. Commaille in the *Comptes Rendus* for August 22. It is proposed by this chemist to employ iodic acid in the determination of tannic and gallic acids, and his method of procedure is as follows: He takes a known volume of liquid holding in solution the astringent matters, and into it he drops a few minims of dilute prussic acid; next he takes a known volume of a solution of iodic acid of a definite strength. These are mixed and boiled for about a quarter of an hour. Then, when the liquid is cool, a small quantity of washed animal charcoal is shaken up with it. The astringent matters combine with portions of the iodic acid, and then the remaining portion is estimated as iodate of sliver. This process shows how much iodic acid has combined with the tannin and gallic acid, and as this is constant, the difficulty is solved. M. Commaille found that a gramme of gallic acid destroys 2·336 grammes of iodic acid, and that a gramme of tannin absorbs 2·320 grammes of the same compound.

GEOLOGY AND PALÆONTOLOGY.

Aqueous Agencies versus Plutonic Ones.—In Sir R. Murchison's anniversary address to the Royal Geographical Society, we find an allusion to M. Schmidt's opinions upon the above subject. It appears that, according to the researches of this geologist, aided by the botanist Glehn and the topographer Schebunin, the region beyond the sea of Baikal is distinguished by a great number of geological formations. Crystalline rocks, however, abound, and the unaltered sedimentary fossiliferous formations are much less extended. Among the latter, the Devonian and Jurassic deposits have been best recognised. The latter have the petrographical characters of the Jurassic rocks of the Caucasus, and contain certain beds of coal, which in one spot are said to pass into graphite. Farther eastward, and along the Saigon, or chief mountains, and on the Amur, below the juncture of the Zeia, there are spread out great fresh-water formations of tertiary age; whilst in the great island of Sakhalin very recent marine tertiaries repose on true chalk and cretaceous deposits. Having discovered what he believes to be many transitions between crystalline rocks and unaltered sediments with fossils, M. Schmidt is of opinion that all such changes have been brought about in an aqueous manner and not by any plutonic or igneous action. Sir Roderick does not appear inclined to accept this view, and goes on to say, that "the ingenious author is obliged, however, to admit the existence of obsidian in one place, and has not yet developed his proofs in favour of his novel system, in which, if I have not been misinformed, he seems to carry the chemical and neptunic theories of Bischoff, to what, I cannot but consider, an extravagant length."—Vide *Address at the Anniversary Meeting of the Royal Geographical Society*, for 1864, p. 40.

Characters of the Beds constituting the Quaternary Formation.—M. Hébert has contributed a most instructive memoir, upon the clays and gravels of these deposits, to the Bulletins of the Geological Society of France. These strata have recently attracted considerably the attention of geologists, and hence the following *resumé* of M. Hébert's conclusions will be of interest to our readers:—(1) The clay of the plateaux in Picardy *may* be the most ancient of the quaternary series; but if so, it must be different from the Limon Hesbayen, of Dumont, which Lyell has identified with the Loess, and must also differ from the clays worked at St. Acheul, above the red gravel. (2) The red gravel deserves more attention than it has yet received, and, in M. Hébert's opinion, should not be connected with the Loess of the Rhine, as has been done by M. D'Archiac. Its uniform presence over a rich tract renders it important as a landmark, and as proving the greater antiquity of underlying diluvial beds. (3) The gravel of Moulin-Quignon may be considered to be derived from *débris* washed down the slope of the hill, and to be a mixture of rolled flints, with red gravel, whose date is not determined. From this it follows that the Moulin-Quignon beds are newer than the red gravel. (4) The Loess of Picardy, which overlies the grey gravel, is older than both the red gravel and Paris Loess. (5) The Loess is not to be regarded as the mud of glaciers once covering Europe. In some instances the red gravel *covers* and penetrates the loess and upper beds of grey gravel, filling large and irregular swallow-holes, and affecting the upper beds of the "Calcaire Grossier," at a height of 55 metres (180 feet 5 inches) above the sea, in exactly the same manner as it affects the grey gravel. He thinks that these results may fairly be attributed to the action of the sea and marine currents, and alludes to the terraces and parallel roads of Picardy as being analogous to those of Glen Roy, and others in Great Britain. (6) The age of the flint-bearing clay is still doubtful, it is probably more ancient than the plastic clays of Picardy. This view is supported by the fact that, in the Forest of Dreux there are found beds of plastic clay overlying this "flint-bearing clay," an intermediate bed of white and yellow sand being also observable.—See *Geological Magazine*, No. III.

New Fossil Fish from the Lower Chalk.—Dr. Günther describes a new fossil fish, which has lately been added to the British Museum collection. It is from the lower chalk of Folkestone, and appears to be the type of a distinct genus. It is twenty inches long, with the vertebral column and the fins tolerably well preserved, whilst the head, unfortunately, has suffered so much that scarcely any portion of it can be distinguished. It is proposed to term the new genus *Plinthophorus* or tile-bearing, from the nature of the peculiar osseous scales which are observed upon the lateral portions of its body. Writing of these scutæ, Dr. Günther observes, "Their general form is arrow-head-shaped, with a longitudinal keel running from one end to the other; the uncovered, broader posterior part is corrugated; the anterior portion, which is covered by the preceding scutæ, is more slender, tapering, and smooth. All these scutes were so connected that they could easily slide one above the other, allowing the lateral motions, and the temporary extension of the body after feeding, or during the season of propagation; and the whole arrangement reminds us of a similar chain of scutes in *Doras* and *Hypostomus*."

The Homologies of Eurypterus have been very clearly indicated by Mr. H. Woodward, in a paper in which he reviews the researches of other palæontologists. Mr. Woodward points out some serious errors into which Professor

Hall fell, while attempting the restoration of this creature, and confirms in the strongest manner Professor Huxley's opinions.

It will be remembered by those who attended Professor Huxley's lectures, in 1857, that he then laid considerable stress upon the homological relationship which exists between the thoracic plate of Eurypterus and the leaf-like appendage of Limulus. This view is now fully corroborated by Mr. Woodwards inquiries.—Vide *Geological Magazine*, for September.

The Fossil Elephant of Malta.—Dr. Leith Adams has lately discovered more relics of this interesting fossil. The specimens were found in extensive excavations, which have been made under his superintendence, among the cavern-deposits and breccias of Crendi. One of the chief points with reference to the elephant in question is the small size of its teeth, which, coupled with other characteristics, leaves no doubt that it was not only distinct from any living or extinct species, but that it was, as regards dimensions, a pigmy compared with them. It is supposed to have been no larger than a lion. Such specimens, together with the bones and teeth of hippopotami, which of late years have been met with in great abundance in different parts of Malta and Gozo, tend to show that these islands are but fragments of what may at one time have been an extensive continent, in all probability connected with either Europe or Africa, or both.

Sir Charles Lyell a Baronet.—There are few men of science in these countries who will not hail with intense satisfaction the news of Sir Charles Lyell's elevation to the Baronetcy. The great geologist is now Baronet of Kinnordy, in the county of Forfar. The honour conferred on him is, we believe, the highest recognition of merit ever bestowed on a geologist in this country, but one which, after all, falls far short of the deserts of the "Historian of Geology."

The Oases of Sahara are divided by MM. Desors into three distinct classes:—1st. Those watered by streams from the mountains. 2nd. Those supplied with water from Artesian wells, the products of a very ancient industry; and 3rd. The oases without water, of which those of the Souf are an example. The oases of the first series are fed either by the streams from the mountains or from subterranean springs, which are found in great and almost constant abundance, and are usually produced by the same cause, viz., the infiltration of the rain water through the fissures in the limestone of the mountains. The oases of Artesian wells are supplied with water from artificial sources. There is generally at a depth of about 160 feet a sheet of water, which forces itself to the surface whenever the intervening soil is pierced. Strange to say, too, in the water thus ejected large quantities of a minute fish are found. The fish are remarkable for the shortness of their ventral fins; the eyes are well-formed, vision being quite perfect; the largest specimen does not exceed two inches in length. They are malacopterygious, and of a clear colour, the under part of the body being of an iridescent blue; they belong probably to the family *Cyprinodontidæ.* Of the waterless oases the best example is that of Souf. The mode which the natives adopt in cultivating the palm is extremely interesting:—"At a depth of eight or ten metres (26 to 32 feet) they reach a moist bed, and planted in this, the dates, from ten to twenty in each hole, develope themselves perfectly. But these cantres called *Ritans* are frequently invaded by the sand, and they require constant attention. This compels the inhabitants of Souf to employ the utmost activity, while giving them habits of industry has resulted in procuring them not only competence, but wealth. All the houses are built of crystalline sulphate of lime, and are roofed with cupolas; so that from a distance it looks like a collection of bee-hives. . . . It is a curious trait in the inhabitants of Souf that, having no other water than that of the wells, and this water never remaining on the sandy surface of the soil, they have no idea of a brook, or a river, or any other kind of running water."—Vide *Geological Magazine*, No. I.

A New Species of Plesiosaurus has lately been discovered by Mr. E. C. Day upon the Dorsetshire coast. The specimen was found between Charmouth and Lyme Regis, in a bed of marl intercalated between two of the uppermost beds of the lower Lias limestone: hence it comes from the middle of the zone of *Ammonites Bucklandi.* The fossil is thirteen feet in length, and exhibits the entire dorsal view of the skeleton with very few bones displaced. Besides the large head there is a very well-preserved jaw, filled with long curved teeth; the cervical vertebræ exhibit well the characteristic pleurapophyses; the dorsal vertebræ and the ribs are well shown, and even the pelvic bones are in great part in their normal positions. The tail, too, is tolerably well preserved, and for the most part occupies its proper place; but of all the parts, the limbs are those in the most complete preservation; in fact, the four paddles with all their constituent bones remain just in the position they must have had when the animal ceased to live. We believe this specimen has been purchased by the authorities of the British Museum, and will soon be described by Professor Owen.

The Glasgow School of Mines.—We regret to learn that this Institution is about to be abandoned, the anticipated subscriptions from the coal and ironmasters not having been forthcoming. This event has been long foreseen, and it is thought probable by those who have experience in such matters, that a similar fate may soon be expected to overtake two or three schools of a like character, which are now dragging on a precarious existence in some of our mining districts.

Coal on the Southern Flank of the Harz.—It seems not unlikely from the explorations of Herr Roemer, of Clausthal, that a new coal field will be found on the southern flank of the Harz. The productive coal-measures are supposed to lie unconformably on the older Grauwacke rocks. The probable district lies about half way between the coal fields of Saxony and Westphalia, and it is thought that the result of mining exploration will be to show a very large deposit of coal of an excellent quality.—Vide *Mining and Smelting Magazine* for August.

Indentations on the Bones of an Irish Elk.—Some very curious marks have lately been observed by Mr. J. Beete Jukes, upon the bones and antler of *Megaceros.* The most striking of those seen were the markings on the tibia and antler tine. There were indentations about two inches broad and a quarter of an inch deep, and they seemed as if they had been each chipped out with some sharp instrument. The impression which they left at first on Mr. Jukes's mind was, that these three indentations were the best evidence that had yet turned up in proof of man having been contemporaneous in Ireland with the Megaceros, and having left his marks upon the bones of an animal which he had himself probably killed. Upon a re-examination of the remains, however, he was struck with the similarity in form between the indentation on the tibia and that on the antler tine ; and on putting them together it was found that they locked completely into each other, fitting with the most close and perfect adjustment. He had previously observed that the surfaces of these two indentations were stained with some irregular streaks of brown colouring matter, but he soon perceived that the pattern of these streaks was exactly the same on each surface, and would when in apposition correspond as closely as the marks of an ink-blot would on the opposite pages of a book, if they were squeezed together while it was yet wet. Moreover, there was a longitudinal crack or crevice on the surface of the tibia, running through the indentation, which at one part split into three little fissures ; and on the surface of the antler there were three little ridges, which exactly fitted into these cracks. In addition to this, there was a longitudinal ridge, running along the outer side of the tibia, and this could also be traced through the indentation, standing up as a slight prominence, and in the antler there was a corresponding hollow or shallow groove, exactly fitting the prominence on the bone like the cast of a mould. To us it would seem as if the two structures (tibia and antler tine) had been grooved by human agency, as we make a mortice now-a-days, for some peculiar purpose. Mr. Jukes, however, holds a different opinion, for he writes, "It was of course obvious that the perfect correspondence of these two surfaces could only be produced by their mutual pressure against each other, under such conditions as would allow each to receive the impress of the other ; and it appeared to me that the whole amount of the indentation had been thus caused." The specimens were found beneath a layer of peat forty feet in depth, and this Mr. Jukes conceives to have been capable of exerting sufficient pressure to cause the gashes which the bones presented. We must certainly say we think Mr. Jukes's view a very far-fetched one, and we are exceedingly sceptical as to the power which such a pressure could exert, being capable of producing such even gashes as those so beautifully delineated in the large plate accompanying Mr. Jukes's memoir.—Vide *Dublin Quarterly Journal of Science*, No. XV.

A new Species of Fossil Red-deer has been discovered by Professor Haughton of Dublin. In the specimens he has found, there are *fourteen* dorsal vertebræ, and the tarsal bones are soldered together in both legs. In the recent red-deer, there are but *thirteen* dorsal vertebræ, and the tarsal bones are free. Dr. Haughton modestly suggests that the specimen entitles him to regard it as a new variety, but we think it deserves to be called a species.—See *Proceedings of Geological Society of Dublin.*

MECHANICAL SCIENCE.

Hooped Cannon.—Professor Treadwell of Havard University, who was one of the first to point out the method of strengthening guns by hoops shrunk on with initial tension, has published another memoir on the subject, in which he discusses the influence of the state of the iron in the hoops as to hardness on the ultimate resistance of the guns. It is well known that by continued cold hammering, and other processes, iron and other metals become hard and brittle, the qualities so induced being easily destroyed, and the original ductility and malleability being restored by annealing at a high temperature. The drift of Mr. Treadwell's argument is to show that in the condition of hammer hardness the iron is best fitted for use in strengthening cast-iron guns, its extension under strain being then in closer relation with the extension of the cast-iron core. In his experiments he employed wire of $\frac{100}{1075}$ inch diameter, and the most important conclusions from these are as follow :—First, that with iron hardened by tension and compression, in the condition of hard wire, the amount of permanent elongation, under tension, is far smaller than the permanent elasticity up to near the breaking-point, and also that the permanent elongation does not begin until about one half the breaking strain is applied. Second, that when the material has been subjected to a strain of a given amount, the repeated application of a strain within that amount produces no further permanent elongation. Third, that when the iron is annealed, the permanent elongation commences at a comparatively low strain, and its extent is large in proportion to the elasticity of the iron. Hence, when annealed iron is applied on a cast-iron gun, it must be loosened, or suffer the cast-iron to break within its grasp before a strain on it up to half its tensile strength has been reached.

Comparing two guns of a calibre of 14 inches, Professor Treadwell estimates the ultimate resistance of one with annealed iron hoops at 540,344 lb. for each inch in length of the reinforce of the gun, and of one with hammer-hardened hoops at 1,199,800 lb. per inch, or more than twice as much.

"*Royal Sovereign.*"—This vessel, now fitted with Captain Coles's cupolas, has made a successful cruise, the turrets proving perfectly manageable in the roughest water, with the vessel rolling through an arc of 21°.

Atmospheric Hammer.—A practical mechanic at Birmingham, Mr. Grimshaw, has invented an atmospheric hammer on the same principle as the famous steam hammer of Mr. Nasmyth, but actuated by air compressed by an air-pump driven by an ordinary belt and pulley. The air is compressed into a reservoir forming the framework of the machine, and serving as an "accumulator" of power.

Armour Plates.—The Iron Plate Committee has closed its labours by some experiments on a target designed by Professor W. Pole. This target represented the side of an iron-plated vessel, 17 feet long and 10 feet high, covered with plates 5ft. 9in. long, by 2ft. 6in. wide, and varying in thickness from $\frac{3}{4}$ in. to $5\frac{15}{16}$ in. The backing consisted of vertical oak timbers, 11 inches thick, outside planking of teak 10 inches, and inside planking of oak 6 inches thick. The armour plates were fastened in the French fashion, with fifteen $1\frac{1}{2}$ inch "wood screws" instead of bolts. The results of the experiment showed the immense advance which has been made in the manufacture of the plates, those on the target being as tough as could be desired; they also proved the great superiority of the French "wood-screws" to our own system of bolts, the plates being held in their place in spite of the most terrific battering; whereas the bolts usually break, and allow the plates to buckle forwards, and ultimately fall off. The superiority of Captain Palliser's chilled shot was again exhibited, and a cast-iron shot with a 35 lb. charge broke up harmlessly against the target. Shot of 160 and 220 lb. weight, of cast steel, from Armstrong shunt guns, penetrated the target with the greatest ease, covering the beach with splinters of timber, and expending their force on Mr. Scott Russell's target behind.

Gun Cotton.—During the meeting of the Royal Agricultural Society at Newcastle, Messrs. Prentice, who have introduced the manufacture of gun cotton in this country, exhibited its destructive powers by blowing up an enormously massive stockade. For this purpose they employed a shell 16 inches long and 12 inches diameter, containing 25 lb. of gun cotton. The shell was fired by electricity, and reduced the stockade to utter ruin.

Drilling versus Punching.—At the meeting of the mechanical engineers at Glasgow, a very lively discussion arose as to the relative merits of the drilling and punching processes of forming the rivet holes for the joints of wrought iron-structures. The almost universally adopted process of punching is open to various objections : it injures the metal of the plates between the rivet holes ; it makes a burred and conical hole ; the holes do not correspond with accuracy. On the other hand, the drill makes a clean accurate cut, but the process is tedious and expensive. Mr. Fletcher, however, described a machine on the general plan of construction adopted by Messrs. Cochrane for drilling the plates of the Charing Cross Bridge, and he stated that this machine drilled all the holes in a large plate of one inch thickness in fifteen minutes, all the holes being drilled at one operation. The drills are pressed with a force of 6 cwt. hydraulic pressure.

Expansive Working of Steam.—Some extensive experiments on the expansive working of steam have been made in America, under Government auspices, the main results of which we summarise below :—

Steam condensed ; no steam jacket ; trials of 30 hours' duration each ; engine performing the same amount of work in each trial.

Cut off.	Initial Pressure of Steam.	Pounds of Water Evaporated.	Pounds of Fuel Consumed.
7-8ths	30·6 lb.	16,622 lb.	1,635 lb.
2-3rds	33·3 „	14,981 „	1,401 „
1-2nd	38·1 „	14,568 „	1,374 „
1-4th	53·9 „	12,826 „	1,245 „

It will be seen that the economy of fuel working at 1-4th cut off, over 7-8ths cut off, amounts to about 25 per cent.

Second series similar to first, but cylinder fitted with steam jacket:—

Cut off.	Initial Pressure of Steam in Boiler.	Pounds of Water Evaporated.	Pounds of Fuel Consumed.
7-8ths	25·93 lb.	12,901 lb.	1,212
2-3rds	25·41 „	11,267 „	1,069
1-2nd	34·64 „	11,188 „	1,086
1-4th	47·51 „	9,632 „	959½

MEDICAL SCIENCE.

Fungi as Agents in the production of Disease.—In one of the numbers of our last volume we detailed the curious experiments of Davaine and others, tending to prove that bacteria and other plants of a similar character when injected into the blood of animals developed certain diseases which proved fatal in a very short space of time. We have now to record the opinions of another set of observers. The results of the recent inquiries of MM. Leplat and Jaillard go to prove that the injection of the plants referred to does not develop fatal diseases. They made ten different experiments upon animals, and drew from them the two following conclusions :—

1st. When bacteria or vibrions are introduced through any medium into the blood of an animal, they produce no injurious results, unless, indeed, the medium itself contains certain virulent agents, for the action of which the other bodies are not responsible.

2nd. If the vehicle employed in injection contain putrid matter in large quantity, there is poisoning of the blood ; but this is not productive of contagious disease, since the blood thus contaminated does not produce similar effects when produced into the system of another animal. These *savans* have also found that the statements that *Pencillum glaucum* produces psoriasis, and *Oïdium Tuckeri* phlegmonous inflammation, are erroneous. The spores of both these fungi were injected into the veins of dogs, without producing any ill effects on the animals.

Relative Actions of Absinthe and Eau-de-vie.—These have been carefully investigated by M. Decaisne, who reports as follows :—

1st. When employed in the same doses and with equal degree of alcoholic concentration, absinthe produces far more marked and serious effects than eau-de-vie.

2nd. Absinthe produces intoxication, and the conditions known as acute and chrorine alcoholisation, much more rapidly than eau-de-vie.

3rd. Absinthe affects the nervous system more than the other, and produces results similar to those developed by a narcotico-acrid poison.

4th. The great danger of absinthe is its liability to adulteration.

5th. Absinthe of good quality, when taken even in moderate doses (a glass or two per day), produces, sooner or later, according to the state of the constitution, diseases of a serious character which especially affect the digestive organs.

6th. Absinthe should not be consumed even in the most moderate doses. Vide *Comptes Rendus*, August 1.

Operation of Alcohol on the Kidney.—M. Perrin, who is so well known in connection with the alcohol question, has just produced a new memoir, in which he shows that under the influence of alcohol, the proportion of excreted urea is not increased. He, however, agrees with those physicians who say, that alcohol though not *absolutely* nutritious, is so relatively, owing to its property of preventing the waste of tissue.

Galvanism as a Surgical Agent.—Voltaic electricity has lately been employed to break down the structure of polypi and similar tumours. M. Nelaton has tried it *successfully* in cases of polypoid tumour of the nostril. The platinum electrodes of a small battery are inserted into the substance of the abnormal growths, and the current is allowed to traverse them, when, after a longer or shorter interval, the tumour is found to be destroyed. Coagulation takes place at the positive pole, while solution is observed at the negative extremity, and, strange to say, the operation is unaccompanied by pain.

Ranunculus versus Cantharides.—It would appear from some inquiries lately made that the tincture of the leaves and stem of the buttercup possesses vesicating properties of a very high order, and bids fair to rival even that best known of blistering media, the Spanish fly. The tincture of ranunculus lasts for a longer period than the cantharides preparation, and this fact, coupled with the absence of injurious effect on the kidney, render it probable that ere long we shall see the buttercup frequently employed in medicine. It is often advisable to apply a blister to the loins in cases of congestion of the kidney, but cantharides cannot be employed for the purpose, because of their tendency to be absorbed, and produce violent inflammation of the urinary organs.

How to photograph the Fundus Oculi.—In the last number of the *Ophthalmic Review* we find a description of a very simple apparatus to be employed in photographing the interior of the eye. The instrument is described by Mr. Rosebrugh, of Toronto, and is of his invention. The eye is illuminated by solar light reflected from plate-glass ; and a sufficient number of the rays of light reflected from the fundus of the eye pass through the plate-glass to form a highly, almost brilliantly-illuminated image of the fundus, in or near the principal focus of a convex lens, placed behind the plate-glass, and of any focal length, from one to eight or ten inches. The tube containing the plate-glass has a second tube attached to its side, and placed at right angles, and through this the light falls from the sun ; the first tube has one extremity adapted to the eye to be photographed and the other fitted to a small camera, upon the plate of which a very perfect image is formed. Altogether the instrument is a most ingeniously constructed one, and must be a great improvement upon the double ophthalmoscope used as an apparatus in photographing the *fundus oculi.*

Animal Mechanics.—Under this title we find a most important paper from the pen of the Rev. S. Haughton, M.D., F.R.S., in the last issue of the *Dublin Quarterly Journal of Science.* He has worked out the question of the mechanical forces of muscles, their duration when in operation, and their value, with the most wonderful degree of minuteness, considering the vague nature of the subject. He lays down the two following principles, or rather *postulates*, as he terms them :—

1st. The amount of work done by a given muscle in a given time is proportional to its weight, that is, to the number of muscular fibres in contraction.

2nd. The mean lengths of the different muscles employed at each point are proportional to the perpendiculars let fall from the centre of motion of the joint upon the direction in which the muscles act.

He considers that the 2nd postulate is supported by these three considerations : (1) The distance through which the point of application of a muscle is moved by its contraction, is proportional to the mean length of the muscle. (2) It is geometrically evident that the perpendiculars let fall on the directions of the muscles, are proportional to the species moved through by their points of application. (3) The Divine contriver of the joint has made a perfect mechanism, and therefore employs a minimum expenditure of force.

Suture of the Median Nerve.—This operation has lately been performed by M. Laugier, and with the most successful results. In the first instance the patient lost all sensation in the thumb and two adjacent fingers ; upon the evening of the operation, sensibility began to be restored and became even more marked on the succeding day, and after a few days it was entirely restored. Hence M. Laugier concludes :—

1st. That after suture of a divided nerve, sensational and motor powers are perceptibly restored in a few hours.

2nd. That this restoration is progressively established.

3rd. Sensations of touch are restored before sensations of pain.

4th. The operation is by no means a very painful one.

5th. The suture may be made of nerves of a very considerable size and importance.—Vide *Comptes Rendus*, t. xviii. No. 25, and t. xix. No. 3.

The Report of the Chloroform Committee was issued some time since, and from it we learn that the strongest doses of chloroform vapour when admitted freely into the lungs destroy animal life, by arresting the action of the heart, whilst by moderate doses the heart's action is weakened some time before death ensues, the respiratory function being generally arrested prior to the cessation of the heart's pulsation. Death is due to the failure of both functions. In order to administer chloroform safely, the proportion of vapour should not exceed 3½ per cent. Its effects should be carefully watched, and the inhalation suspended when the required anæsthesia is produced. The energy with which chloroform acts and the extent to which it depresses the force of the heart's action, render it necessary to exercise great caution in its administration, and suggest the expediency of looking for another and less objectionable anæsthetic. Ether, says the report, produces requisite insensibility, but is slow and uncertain in its action. It is, however, less dangerous in its operation than chloroform. The committee on the whole concur in the general opinion, which in this country has led to the disuse of ether as an inconvenient anæsthetic. A mixture composed by measure of three parts of ether, two parts of chloroform, and one part of alcohol, is regarded as a safer agent than pure chloroform. Artificial respiration is the most certain means of restoring life after poisoning by anæsthetics of any kind. By this means resuscitation may generally be accomplished after natural respiration has ceased, provided the heart continued to act. If due care be taken in the administration of chloroform, no apparatus need be employed. *Free admission of air with the anæsthetic is the one thing necessary.* Three and a half per cent. is the average amount, and four and a half the maximum proportion of chloroform to atmospheric air, which is either needful or safe. If air be freely admitted with the vapour, any apparatus may be employed, though none is necessary.

Spontaneous Discharge of a foreign Body from the Antrum, in which it had remained for forty-two years.—A very curious case of this kind occurred this year at Bologna. The patient, a man aged sixty-five, was admitted into hospital for rheumatism, and some time after he discharged with some effort from the left nostril a portion of the blade of a knife, about an inch and a half long. When questioned as to the origin of this foreign body, the man remembered that in the summer of 1822, during a midnight brawl, he received three blows with a knife, one of which wounded him above the left cheek-bone. In forty-eight hours he considered himself cured, although there was some swelling, and he had a sensation of the presence of a hard body above the third upper molar of the left side. He afterwards felt a hard body in the left nostril, from which pus and occasionally blood came at intervals. Signor Roudolphi detected a longitudinal depression of about an inch and a half in length on the surface of the alveoli at the part referred to. Upon introducing the finger into the left nostril he was enabled to pass it through an aperture corresponding to the opening into the antrum of Highmore, and satisfied himself by the smooth polished surface of the interior of this cavity, that the finger was really in the maxillary sinus.—Vide *Bull di Bologna*, May, 1864.

Development of the Upper Jaw.—Mr. Hulme, who continues his very well-compiled and useful additions to our knowledge of this subject, describes the mass of tissue out of which the upper maxilla and the intermaxilla are formed as being composed of nuclei or cells held together by some amorphous matter, the whole being covered by a layer of pavement of epithelial cells. The first condition of the osseous tissue is in the form of cartilage, and these cartilages correspond in number to the separate elements from which the maxillary bones are developed. There is therefore a cartilage from which the incisor-bone is developed, one from which the rest of the superior maxillary bone is developed, and two in the remainder of the visceral arch from which the lower jaw is formed, one corresponding to each half. While the cartilages are undergoing these modifications of form, the surrounding tissue is becoming converted into the various soft parts surrounding the bones.—Vide *Dental Review*, July, 1864.

Iridectomy in the Cure of Glaucoma.—The wonderfully successful operation originally devised by von Gräfe, and so strongly advocated in this country by Mr. Bowman, has found a new supporter in M. A. Testilin, who passes a high tribute of praise to Mr. Bowman for his adoption and defence of the operation. He thinks that the lucid, vigorous, systematic, and courteous manner in which the English surgeon has discussed the subject, cannot fail to extend his reputation very considerably, and must tend to make the cause of iridectomy triumph in England, as it has done already upon the continent.—Vide *Ophthalmic Review*, July.

The use of the term sclera is very ably justified by Mr. Thomas Windsor, who shows that in adopting this word we are not introducing a new term, but merely going back from a denomination (sclerotica) invented during the dark ages, to one employed by the Greeks. It appears that the word *sclerotica* was first coined during the middle ages, and probably about the time of Mundinus, an opinion which is supported on the authority of Joubert.

M. Kœberlé on Ovardotomy.—This distinguished surgeon thus reports the results of his cases to the French Academy. The operations performed by me during the past two years have been twelve in number; of these nine have been followed by cure and three by death, which generally came on from the third to the eighth day after the operation. One of the patients who had been affected with cancerous tumours of the ovaries, was completely restored to health, but afterwards died (owing to the development of cancer in the uterus), six months after the removal of the ovaries. The other cases have enjoyed perfect health since the performance of the operation, and one of them has been delivered of a child weighing more than *eight* pounds. Of the twelve individuals operated on, five were submitted to double ovariotomy; on three others enucleation of the Gräfe vesicles had been performed. In one case the removal of the ovaries deprived the patient of a painful hysterical affection from which she had previously suffered. The proportion of successful cases was 75 per cent. These results are extremely remarkable when contrasted with those of several operations performed in Strasbourg, all of which were fatal.—Vide *Comptes Rendus*, August 17.

Influence of Tobacco upon the Nervous System when absorbed by the Skin.—Some time ago a French sailor, in endeavouring to smuggle a quantity of tobacco, placed the leaves next his skin in this way, covering nearly the entire surface of his body. The result was that the perspiratory fluid acting upon the tobacco extracted some of its poisonous principles, which being then absorbed, produced excessive stupor and nausea. This case having been reported to the French Academy, and having interested the *savans*, M. Gallavardin compiled a list of various cases of tobacco-poisoning, as shown by intoxication, and presented them in memoir-fashion to the society. Among the cases cited we find the following :—

1st. After the application of tobacco-juice in a case of chronic exanthema of the neck.—(*Landerer.*)

2nd. After the external application of tobacco.—(*Truchsess.*)

3rd. By frictions made with the residue of tobacco on parts denuded of skin.—(*Westrumb.*)

4th. After the application of tobacco juice to an ulcer.—(*Walterhall.*)

5th. After the application of powdered tobacco to the skin of the bend of the thigh.—(*Keskring.*)

6th. After the application of a liniment composed of tobacco and butter to the heads of three children.—(*Keskring.*)

7th. After the envelopment of the hands, arms, thighs, and legs in linen soaked in a warm and strong decoction of tobacco.—(*Marigues.*)

From the above list of cases we are fully justified in concluding that tobacco when applied to the skin (whether the latter be entire or not), produces symptoms of intoxication which are quite analogous to those observed when the active principle of tobacco has been absorbed into the system, through other channels.—Vide report of M. Gallavardin's paper in *Comptes Rendus*, August 1.

METALLURGY AND MINING.

How to Supply High-Pressure Air for the Lights in Mines.—A new method of supplying compressed air to the lanterns in mines, is proposed by the Rev. W. R. Bowdich, of Wakefield, and is as follows :—The air having been condensed by a pump or other suitable means, is conveyed in pipes to a receiver, and thence to the light to be supplied. The light naked, or in a safety lamp, is placed in a lantern, which has an aperture for the admission of the pure air, and one for the exit of the surplus air and products of combustion. The condensed air is conducted through a pipe which fits closely into the lantern, and by this air combustion is supported. The air being supplied to the lantern under pressure, prevents the entry of fire-damp or any other dangerous gas that may surround the apparatus. Air under pressure is apt occasionally to extinguish the light to which it is supplied, and to flow to waste, if the current be not properly regulated : to prevent this it is passed through a pipe obstructed by screw-plugs, so that its flow may be regulated according to the supply needed.—Vide *Mining and Smelting Magazine* for September.

A huge casting of a 160-ton anvil block was some time ago successfully accomplished at the works of Messrs. Stanley & Co. The casting-shop in which the monster was brought into shape and form, was that in which the previous castings had been made. In the centre of the floor a great pit was dug, and in this the mould was framed, the anvil being cast with its face downwards. The mould was twelve feet square at the base, 11 feet 6 inches deep, and was calculated to contain nearly 170 tons of iron, when full. At intervals outside the shop were five furnaces, and at six o'clock in the morning these began to pour their molten contents into a huge chasm, and continued till about five o'clock, when the operation was declared to be successfully completed. The scene in the casting-shop was a strange one to ordinary eyes. From four or five different points, streams of liquid fire were slowly flowing towards the edge of the pit, where they fell, amid showers of starry sparks, into the vast seething mass beneath. A metal rod was thrust through the mass to test its perfect liquidity, and this having been satisfactorily proved, the top of the pit was carefully closed, to be opened again at the expiration of seven weeks, the period requisite for the cooling of the metal. This monster anvil will have, when completed, to sustain the blows of a 25-ton Nasmyth's steam-hammer, and will be employed in forging the 600 and 300-pounder guns that the Messrs. Firth are manufacturing for Mr. Whitworth.—Vide *Artizan*, Sept. 1, 1864.

The Purification of Plumbago Crucibles is achieved by Mr. T. Vaughan Morgan's method with considerable ease. The plumbago, in its impure condition, is brought to a low red heat in an oven or retort, and by this means the iron present becomes converted into a magnetic proto-carbide, which can then be removed by magnetic or electro-magnetic action.

Scottish Coal and Iron.—From Mr. W. Moore's useful paper, lately read before the *Institution of Mechanical Engineers*, we learn the following important particulars :—The valuable seams of the Glasgow coal field are situated in the counties of Lanark, Stirling, Dumbarton, Renfrew, and Linlithgow, and lie between the new red sandstone and the Hurlett coal. They are divided into upper and lower series of minerals. Those seams lying above the Garnkirk limestone form the upper series, and those beneath the Possil limestone form the lower series. It is from the upper series that the coals have been taken for the supply of household, manufacturing, and iron-smelting purposes, during almost the whole history of the coal fields ; and the upper seams in this series are collectively known as the Glasgow and Monkland seams, extending over an area of about 37 square miles, more or less interrupted by faults. There are also several minor seams of coal in the upper series, which are, however, mainly local, and worked only in the special districts in which they are found. The main supply of iron for the use of the Scotch iron-works comes from the two Possil ironstones, the two Garscadden blackband ironstones, and the Paisley ironstone. The whole Glasgow mining district contains 111 blast-furnaces, which produce 900,000 of pig-iron per annum, and consume about 2,500,000 tons of coal, 1,134,000 tons of ironstone, and 445,000 tons of limestone. The entire district contains about 260 collieries, which raise annually about 8,500,000 tons of coal, or nearly 77 per cent. of the whole produce of Scotland.

The New Raschette Blast Furnace.—A novel form of blast furnace is the invention of a native of St. Petersburg, named Raschette. It consists first of a blast furnace, the hearth of which, when bisected by a horizontal plane, presents a narrow, long rectangle, the two short sides of which are to be used as working sides, and its two long sides for two or more rows of *tuyeres*, both sides increasing gradually from the hearth up to a point near the throat, in such a manner that a steady and constant discharge of material from the throat to the hearth is obtained, the layers of ore, fuel, and fluxes, preserving their relative positions all through. It has, moreover, a series of lateral *tuyeres*, which serve to maintain a smelting and oxidising zone of uniform temperature, and slight vertical depth, throughout the entire length of the furnace. In addition to the foregoing it has certain arrangements connected with fire-flues under the bottom, and *slotted* air chambers, which render its action more rapid and effective than the ordinary furnaces.

A New Form of Crushing Mill is proposed by Mr. Fauchery, of San Francisco, in which the jaws are so arranged as to resemble an enormous pair of pincers, working cross-wise, the motion being applied by an oval wheel, made to revolve between the arms, and closing the jaws at each revolution, the process of opening being effected by a spring.—Vide *Mining and Smelting Magazine*, No. 33.

Mining Survey of the Sandwich Islands.—It seems likely that the representatives of the Harvard University will apply to the authorities at Honolulu, for permission to carry out a geological survey of the Sandwich Islands ; and we understand that considerable local interest is felt from the likelihood that the Hawaiian government will give the necessary leave for settling the oft-mooted questions, whether gold exists in Koolan, and also whether there is coal or any other useful mineral.

Casting Ingots of Steel.—Mr. W. D. Allen, of Sheffield, suggests the prevention of the sudden chilling of the steel, by coming in contact with the iron mould, and also the protection of the mould from injury by direct contact with the molten metal. The means he employs is the lining the inside of the mould with a thin coating of clay, loam, or other suitable material, that is a slow conductor of heat. The moulds should, in such cases, be perforated, to allow of the escape of the expanded air contained in the lining.

An Improved Method of Crushing Ores is that of Mr. Pengilly, which consists in the use of tapering rollers, whose thin ends are next the point at which the ore is introduced. These rollers are grooved, the corrugations of one being arranged at right angles to those of the adjacent roller, which works against it.

METEOROLOGY.

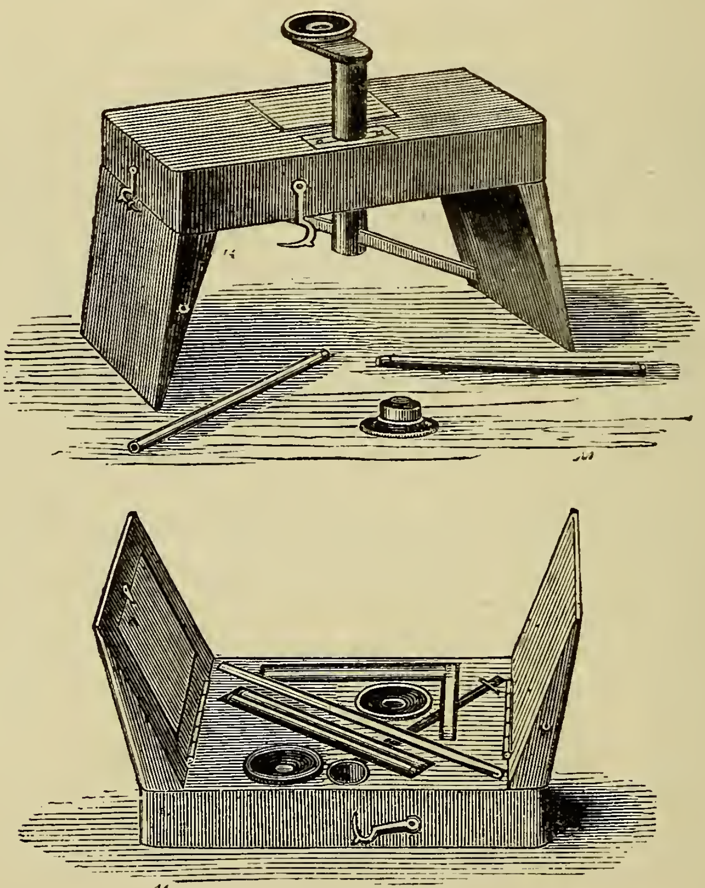
An Enormous Aërolite was some time ago discovered by Mr. Le Gould, of Queensland, and was described by him to the members of a local philosophical society. When travelling beyond the Isaacs, a branch of the Mackenzie river, on passing a rocky valley, covered with large ferns and good-sized trees, he came upon a large gum-tree, divested of all its bark and leaves, which lay across its track. It had been sharply broken through its base (which was five feet wide) at a height of five or six feet from the ground. Wondering what could have broken so huge a tree in so strange and sharp a manner, as it had not the appearance of having been struck by lightning, he dismounted to examine it, and found a great bruise in the trunk. On proceeding to search the locality he found, at a distance of about fifty yards, something which appeared like a large cannon-ball. Knowing, however, that no artillery of so large a calibre had ever been so far inland, he proceeded to examine it more closely, when he discovered that it was an aërolite. It was of a dark metallic colour, extremely hard, and about ten inches in diameter; in fact, it resembled a ten-inch shot, and was about the same weight; it was perfectly round, save on one side, which was slightly flattened, and its surface was extremely smooth, and very slightly perforated. He promises a further investigation of this interesting specimen.

Rainless Districts.—In a letter to the *Geological Magazine,* Professor Ansted seems to imply that the term *rainless* district is only used in a relative sense, and that there are no localities entirely immune from rain. Thus he says, it is convenient to call certain large areas "rainless," though rain occasionally falls on parts of them, and to include others among provinces of autumn or winter rains, which are as dry as the former. "Certainly," he writes, "Canada and Ireland would not be incorrectly regarded as excluded from earthquake districts, though a shock now and then may be felt in either country."

MICROSCOPIC SCIENCE.

Tolles' New Binocular Microscope.—It would appear that the celebrated American maker has produced an instrument whose power far exceeds those of any yet produced upon Mr. Wenham's principle. It appears that apparatus by which the effect is produced is situated, not at the lower portion of the body, but is placed absolutely in the eye-piece, and hence can be easily adapted to any microscope, which it will only lengthen about three or four inches. On comparing it with a Smith and Beck's binocular, with as low a power as $\frac{2}{3}$ inch, there was observed a marked difference as to definition both by reflected and direct vision. In the new instrument with the $\frac{1}{10}$ inch the fine lines of *Hyalodiscus subtilis* and *Grammatophora subtilissima* can be distinctly observed; and even with the $\frac{1}{5}$ inch the fine endings of the wedge-shaped markings on *Podura* may be easily perceived. "The eye-piece, with its present arrangement, is a first-class erecting one, giving with the various powers up to the $\frac{1}{10}$ full and clear fields beautifully illuminated by the mirror alone, and without any special trouble with the higher powers, as is the case with Mr. Wenham's arrangement." Some facts as to the structure of certain of the diatoms have been brought out with wonderful distinctness; there is a rotundity and solidity which gives a more complete idea of the structure of such forms as *Aulacodiscus Petersii*, and the *Amphiproræ,* than can be had by any monocular vision. With the lower powers 3 inch to $\frac{2}{3}$ or $\frac{4}{10}$ nothing can exceed the beauty and brilliancy of the objects when seen for the first time with the new apparatus." The power of the eye-piece is variable, as with Wenham's binocular. No alteration is required for polarization experiments; but the prism is inserted in precisely the same place and manner as with the single eye-piece. In fact, the old arrangements of the microscope are left, the whole effect of binocular vision being produced in the eye-piece. The writer of the paper from which we have made the foregoing extracts, is not at liberty at present to explain the principle upon which Mr. Tolles has been enabled to divide the pencil so far from the objective, but doubtless the whole plan of the apparatus will be made known in a short time.—Vide *Silliman's American Journal of Science and Art*, July, 1864.

Cheap Form of Dissecting Microscope.—Mr. Highley has just devised a form of dissecting microscope for the use of amateurs and beginners, which bids fair to become popular. It is somewhat upon the principle of the late Professor Quekett's instrument (which was itself planned by Mr. Highley), and consists of a mahogany stand, supported by lateral folding props, bearing a vertical limb of brass, with a horizontal projection to which the lenses are fixed. The vertical limb, instead of being moved by rack and pinion as in the more expensive apparatus, is elevated and depressed by a simple lever which works beneath the stage, and gives an easy sliding movement to the piece. The lenses are two in number, and are of average focus and defining power. When placed in its case the entire instrument may be conveniently carried in an ordinary sized pocket. It is sold at the moderate price of 12s. 6d., and was, we understand, devised to meet the requirements of one of our large public schools, in which botany is, in future, to be a branch of education.



Mr. Highley's new Dissecting Microscope.

The following is a list of notices of papers on subjects relating to histology, &c. :—

Botanical Section—

Peculiar Mode of Conjugation among Navicular Diatomaceæ.

Presence of Vegetable Spores in the Atmosphere.

Medical Section—

Fungi as Agents in the Production of Disease.

Development of the Upper Jaw.

ZOOLOGICAL SECTION—
The Spontaneous Generation Controversy.
The Colour of Corals.
Action of the Cicatriculi of the Egg.
Phenomena observed during the Death of Sponges.
Anatomy of Anodonta.

MINERALOGY.

The Nephrite of New Zealand.—This mineral, which is held in high esteem among the natives as a material for weapons, tools, and various ornamental objects, occurs exclusively on the west coast of the south island which is called Te Wari Pooramoo, which means the place of the green stone. It appears generally in the form of pebbles, in river-beds, and on the sea-shore; it is, however, said to occur also in masses in the vicinity of considerable veins of serpentine. The natives distinguish by name a great number of varieties, differing in hardness, colour, and translucence. These varieties may be divided between the two following groups:—

1. Those of an intense green (generally leek-green), more or less translucent, with a hardness between that of felspar and quartz; compact, not schistose.
2. This group is of less value than the first, and its members are analogous in physical properties and chemical constitution to M. Damours' "*jade blanc,*" and probably belong to the family Amphiboles.—Vide *Geological Magazine*, No. III.

Analysis of Pollux from the Island of Elba.—The mineral pollux, which is of extreme rarity, and which has been only imperfectly analyzed by Plattner, who found in it silica, alumina, potash, and soda, has been investigated by M. Pisari. The latter chemist found that the metal cæsium forms an important constituent of this mineral. Its density is 2·9; its lustre glassy and colourless, and its hardness about 6·5. The following is a tabulated arrangement of its constituents:—

Silica	44·03
Alumina	15·97
Oxide of Iron...............	0·68
Lime	0·68
Oxide of Cæsium	34·07
Soda & a little lithium ...	3·88
Water........................	2·40

Vide *Bulletin de la Société Chimique*, VI., 456.

The Colouring Matter of the Emerald.—Contrary to the conclusion drawn by Lewy in 1858, that the colouring matter of the emerald is organic and is destroyed by heat, MM. Wöhler and Rose declare that the colour is due to oxide of chromium. They kept an emerald at the temperature of melted copper for an hour, and found that although the stone became opaque the colour was not affected. They then fused some colourless glass with an exceedingly small quantity of oxide of chromium, and the result was a colour exactly like that of the emerald. Hence they concluded as above stated.—*Comptes Rendus*, t. lviii., No. 26.

Mineralogy of a Meteorite.—Some time ago, Professor Kengott, in arranging certain specimens in the mineralogical museum of Zurich, discovered a specimen marked "native iron from Styria." Suspecting it to be meteoric, he sent it to the director of the Imperial Museum at Vienna, who had it cut and polished. Subsequent treatment with acids left no doubt of its cosmical origin. It also contained crystals, which appeared to be *Olivine* and *Pyrosene*, and its general character seems to identify it with the meteorite which fell, many years since, at Steinbach, in Saxony. It may be mentioned, that no meteorite has yet been known to have fallen in Styria. "It would be interesting if the directors of museums would submit any specimens of native iron they may have in their possession to similar tests."—Vide *Chemical News*, July 9.

Composition of Parisite.—MM. Damour and Deville have given an analysis of this mineral, which is composed of carbonates and fluorides of *cerium, didymium, lanthanium,* and *lime.* Its density is 4·358, and it has a hardness intermediate between that of *apatite* and *fluorine.* It is infusible in the lamp-flame, but certain specimens when heated in a test-tube crumble down and are resolved into a multitude of exceedingly fine scales. The form under which it usually presents itself is that of the regular hexagonal prism, and its colour is yellowish-brown. It is unacted on by cold acetic acid ; but cold nitric acid dissolves it slowly, leaving a white residue composed of scales of fluoride of calcium, and cerium.—Vide *Comptes Rendus*, August 8.

PHOTOGRAPHY.

The Last Photographic Exhibition.—The fears we expressed in our last with reference to the exhibition of the Photographic Society have, unfortunately, been more than realized ; for, in every respect, it has proved a failure. The collection, for want of space, was an unusually small one, and, although good, contained so few works of an interesting or novel character, that our surprise at continually finding the little room empty, was, after a first visit, considerably diminished. It was, as we expected, too literally the exhibition of the society, all, or very nearly all, the works contributed being the productions of members. The artistic photographs of Mr. H. P. Robinson, the clever enlargements of Mr. Alfred Harman, Mr. Swan's carbon-prints, and some photo-zincographic and photo-lithographic specimens by Colonel Sir Henry James, Mr. Toovey, and Mr. Osborne, were the most deserving of special notice, if we except the very charming and beautiful little *pictures* sent by Lady Hawarden, who deservedly carried off the principal of the several medals awarded. Our monthly contemporary, the *Art Student*, says, "One of the most important and attractive features of former exhibitions—coloured photographs—was this year sacrificed by a ludicrously prudish affectation of being intensely mechanical and scientific. Extremes meet ; from unhesitatingly introducing life-size paintings, simply because they were drawn by the aid of a camera, we have the most harmless and solitary brush-mark to remove a trivial defect condemned as excluding an otherwise splendid production from the reward honourably and fairly due to its producer." This allusion is to some beautiful landscapes by Mr. Annan, one of which would have carried away a medal but for the "defect" mentioned.

An Improved Solar Camera.—Towards the end of August last, a singularly perfect collection of enlarged photographs were exhibited at the establishment of Mr. Thomas Ross, the optician. These were shown in illustration of a new dialytic enlarging apparatus, invented by M. D. Monckhöven, a name long and favourably known to the scientific portion of the photographic world, although that of a very young man. It is based upon the principle of Woodward's American solar-camera, but the field of illumination obtained is more equal, the possibility of distortion is avoided, and it works with a greater degree of ease and certainty. Its chief exterior features consist in an improved mode of working the external reflector, and in the curves of the condenser, being so calculated as to reduce its spherical aberration to a minimum. But the most original and valuable improvement is in the introduction of a new lens, in the form of a divergent meniscus, placed at a distance equal to that of its diameter from the condenser, and made very thin in order that as little light as possible may be lost by absorption. This lens acts by bringing the central and marginal pencils of light to one plane (represented by the negative as placed within the camera), and also by bringing into its focus a larger body of light than was obtainable by the older process. The object-glasses, used to transmit the image, also have certain peculiarities for cutting off diffused light, &c. The specimens produced by this apparatus speak highly for its capabilities; but we are sorry to hear that it is likely to be very expensive.

The New Magnesium Light.—Dr. R. L. Maddox has recently detailed his mode of using this new light as applied to photo-micography. He says of the light:—"It was very late in the evening before I had time to try it with my usual helio-camera apparatus. Having removed the prism, I placed a small paraffine lamp so as to illuminate the object, condensing the rays by the small crossed condenser of Smith, Beck, & Beck's microscope. After obtaining a careful focus on the screen with the two-thirds objective, the exact distance of the centre of the flame from the condenser and the base board was noted. The two-thirds objective used was corrected by a back lens for union of the actinic and visual foci. A *small* lighted spirit lamp was then arranged to replace the paraffine lamp. The image on the screen was now scarcely visible. A prepared wet collodion plate was put into the frame, the piece of wire held in one end in a pair of pliers, the shutter opened, the shade between the condenser and object removed, and the wire instantly placed somewhat obliquely, for one-fifth of its length, in the flame of the spirit lamp. It soon ignited, emitting a brilliant light, and was advanced as equally as the hand could regulate, according to the rate of consumption. It gave out many scintillations, and on reaching the point of the iron nippers, finished by a smart explosion (possibly the ends of the pliers were damp). The wire (1¼ inch) lasted but a few seconds. Portions of the wire (three-eighths to half an inch) were left unburnt." The resulting photograph (the leaf insect of the sycamore) when contrasted with one of the same minute object taken in sunlight, is very deficient in sharpness and definition. This difference between photographs taken by artificial light and by sunlight always seems to exist, and many theories have been advanced to account for the fact. The editor of the *British Journal of Photography* suggested to Dr. Maddox that the actinic and visual foci of the objective might be differently affected by the two different modes of illumination, and that, therefore, the usual law might not hold good; asserting that from spectra experiments he had made, he was confident some such minute difference had existence. Some years ago, M. Claudet called attention to a difference between the visual and the actinic focus observed in connection with an ordinary compound photographic lens, the changes varying with different portions of the same day. Dr. Maddox agrees with his friend the editor, but believes that other causes intervene; because, whatever the position of the lens, it is still the same, whether that position projects before or beyond the visual focus. Another difference observed by Dr. Maddox is one which we think might reasonably be looked for, viz., the difference in the effects produced by certain colours photographed by artificial light and those photographed by natural light. A few experiments in this direction might be valuable to those who are engaged in copying paintings, a very important and promising branch of the art-science. Professor Piazzi Smyth is said to be experimenting in this direction.

But if the new magnesium light fail in producing specimens of micro-photographs, the very cause of that failure is in other departments of the art a positive gain. We have seen many portraits taken with its aid, which were softer, rounder, and far more truthful in their rendering of texture and general effect, than were similar portraits taken in daylight. To facilitate the use of this light in the hands of photographers, Messrs. Solomon & Co. of Red Lion Square, have introduced a lamp in which it can be very conveniently and effectively burned. This is the invention of Mr. Alonzo G. Grant, an American gentleman residing at Nottingham. The wire is wound on spools, and is drawn between cylinders and through a tube by a clock-work arrangement under immediate control, so that it continues to be pushed forward, or not, according to the will of the operator. In order that the light may be continuous, two separate wires are burnt, so that should the flame of one, from accident, be extinguished, that of the other would immediately re-light it. A parabolic reflector is used behind the flame to strengthen and direct the light. The instrument is very complete, and, we believe, economical.

The Carbon Process.—A paper on photographic painting in carbon was read before a recent meeting of the Edinburgh Photographic Society, by Mr. W. H. Davies, a talented photographic amateur, who has experimentalized in this direction for the last four years. The process described was very similar to that detailed in our last, and several members of the society spoke of specimens produced by it which they had examined long previous to the announcement of Mr. Swan's patented process.

A New Ophthalmoscope for Photographing the Internal Surface of the Eye.—This interesting instrument was described by Mr. A. M. Rosenburgh in a paper read before the Canadian Institute, and is thus described:—Two brass tubes, 1½ inch in diameter, respectively 4 and 2½ inches long, are fitted to the aperture of a small camera, so that they move freely in a collar of brass, and the shorter tube is turned towards the light. A double convex lens is placed at the inner extremity of the illuminating tube, and as close as possible to its juncture with the camera tube, being 1¼ inch in diameter, and having a focal distance of 2½ inches. The camera is 3 inches square and 7 inches high, and is provided with a base six inches square, to insure steadiness. At the aperture in the centre of the anterior side, a brass collar is fitted, through which the tube containing the lenses slides. At the opposite side of the camera is a central aperture, 2½ inches square, behind which is the ground, or focussing glass, also 2½ inches square, moving in grooves, &c., in the ordinary way. The mode of using the instrument is thus described :—A table being placed in the sunlight, the shutters are closed, and a beam of light admitted the size of the illuminating tube ; but this is not absolutely essential if the diffused light is excluded from the camera, and the usual focussing cloth used. The camera and tube being in their proper positions, a cone of light will issue from the end of the camera-tube through the centre of the aperture in the diaphragm, forming a focus about half an inch from the outside of it. The cat or rabbit to be experimented upon (the inventor has not yet applied it to the human eye) is secured in a box of the required size, with the head projecting through an aperture prepared so as to retain it in one position. An image—very clear and bright—of the optic nerve, vessels, &c., can then be obtained by focussing while the eyelids of the patient are held apart by an assistant, the pupil of the eye to be operated upon having been previously dilated with atropine. The inverted image on the ground-glass, when in focus, gives the optic-nerve entrance, distribution of the arteries, the veins, &c., very distinctly and magnified about four diameters. This is then photographed in the ordinary way, the exposure being about five seconds, although this might be considerably abbreviated, we should think. In ophthalmic examinations of the interior of the eye, artificial light should be employed ; the best being that from the gas argand-burner arranged as a table-lamp, with flexible tube attached. The flame should be brought within two or three inches of the entrance of the illuminating tube, and the instrument placed on the same horizontal line. A screen to shade the ground-glass and the observer's eye should be used. At the conclusion of his valuable communication, Mr. Rosenburgh said he hoped his "instrument might contribute something towards awakening an increased interest in ophthalmoscopic science, as the ophthalmoscope is, without doubt, as essential in investigating diseases of the eye as the stethescope in diagnosing affections of the heart and lungs," and trusted "its use would aid in banishing from ophthalmic nomenclature the indefinite term 'amaurosis,' where, as Walther states, 'the patient and the physician are equally blind.'"

Photographing Electric Light.—The Astronomer Royal of Scotland (Professor Piazzi Smyth) in a letter to the *British Journal of Photography*, of August 5th, calls attention to a singular electrical effect produced in a dry plate negative of some house-roofs. Every chimney-top was surmounted in the print by white streaks of light (black in the negative), although nothing of the kind was detected either in the scene itself or on the focussing glass. The lens employed was a good one, the stop a small one (0·3 inch), and the definition obtained, of course, extremely sharp and clear. The Professor concludes, after a careful consideration of all sorts of possible and impossible causes, that the phenomenon was "an electrical one, invisible to the eye, but abundantly visible or sensible to the photographic camera, and the occasion was perfectly agreeable thereto ; for it was at the conclusion of a week of unusually hot, calm weather, and the sky had that morning become clouded with forms of clouds eminently electrical." This conclusion is strengthened by some experiments, arising out of a similar event, conducted in America by Messrs. Günther & Dove, who used the Geisler tubes in a dark room, and succeeded well in photographing the stratified discharge. A more careful and exhaustive series of experiments, conducted afterwards by Professor Rood, thoroughly established the facts advanced by each of the above-named gentlemen.

Important New Work.—A new and practical treatise on photographic optics is announced from the pen of Dr. Monckhöven. Intimately conversant with this subject in all its practical as well as scientific departments, this work is likely to supply a want which photographers have felt for many years.

Photography on Canvas or Panels for Painting.—The *Art Student* gives the following simple process for transferring photographs to these surfaces for the painter. A sheet of albumenized paper about two inches larger than the photograph to be transferred, is fastened by the four corners to a drawing-board, and covered with a solution of gum to within about half-an-inch of the edges. When this is dry, a thick coat of chloridized albumen is passed over it, and the surface shielded from dust. On paper thus prepared, the proof is printed. When this is done, the dried print is coated with gelatine, and the surface is afterwards gummed upon a sheet of white paper, stretched on the drawing-board as before, but with the edges fastened down. When this is again dry, the first applied paper may be soaked with warm water, until it is easily removed. After drying once more the proof is gummed, and placed upon the canvas or panel, and when it is again dry, the sponging with warm water is repeated and the operation complete.

PHYSICS.

The Spectrum of Jupiter.—M. Secchi, so well known for his spectroscopic researches, has given the French Academy a paper detailing the results of his investigation of the light of Jupiter. He found in the spectrum special atmospheric lines, which do not correspond with our own. The line C is entirely wanting in Jupiter, and the position of other lines is different. The solar lines exist in the spectrum of the planet; but the atmosphere has a far greater absorbing power than ours.

The Passage of Gas through Homogeneous Solid Bodies.—This subject, the consideration of which was commenced some time back by M. Deville, has been lately brought by him before the scientific world. His experiments were made upon the passage of hydrogen through the walls of wrought-iron tubes. A wrought-iron tube filled with nitrogen is placed in a porcelain tube, through which a current of hydrogen is passed. Upon observing the pressure upon the inside and outside of the iron tube, it is found that that of the interior may become almost double that of the exterior, in consequence of the hydrogen permeating the walls of iron and adding its pressure to that of the nitrogen. Unless the temperature is very high, no nitrogen passes out; but at very exalted temperatures it is found that the two pressures become nearly equal, in consequence of the intermolecular spaces becoming so dilated as to allow the nitrogen to pass through them. Hence it follows, that if we were acquainted with the law of the dilatation of these inter-molecular spaces, we could determine the relative sizes of the molecules of hydrogen and nitrogen. When the internal pressure is at the highest mark, the mixture is analyzed. M. Deville has given the results of several analyses, and from them we select the following one :—

External Pressure of Hydrogen.	Internal Pressure of Mixture.	Composition of Gases in Iron Tube.		Pressure of each Element.
760mm.	1,451mm.	Hydrogen	57·4	833mm.
		Carbonic oxide	05·2	75
		Nitrogen	37·4	543
			110·0	145

Such results the author of the paper confesses to be quite in opposition to all that is known relative to the laws of diffusion of gases. They may be explained by one of the two following suppositions :—

1. In the interior of the tube a mixture of nitrogen and hydrogen acts in the same manner as homogeneous matter, drawing toward it the pure hydrogen from the exterior, as though part of the physical properties of the hydrogen were destroyed by admixture with nitrogen. This explanation it is hard to admit in the present state of science.

2. In the interior the gases are at rest, but externally they are in motion. If the results may be attributed to this, then it would be possible to draw some very important conclusions in regard to the mechanical theory of heat, and to form new views concerning the constitution of gases, and Graham's recent laws ; but before taking these steps, the author proposes to re-investigate the whole phenomena.—Vide *Comptes Rendus*, July 15.

The Movements of Chemical Matter when in Films upon the Surface of Water.—That indefatigable physicist, Mr. Charles Tomlinson, has been making a new series of investigations into the movements of chemical matter when in films upon the surface of water. Eugenic acid is the compound which has most recently been the subject of his inquiries. He finds that when a drop of this liquid is placed on the surface of two fluid ounces of distilled water in a glass capsule two and a half inches in diameter, it forms what is termed a cohesion figure, consisting of a flattened disk of about $\frac{2}{10}$ths or $\frac{3}{10}$ths of an inch in diameter, which sails about on the water with a vibrating motion of the edge, not nearly so vigorous as the disk of creosote under similar circumstances. The eugenic acid disk often splits up into two or three smaller ones, which revolve round each other, and as they become smaller move more rapidly, and at length disappear in wild gyrations. The manner in which the disk is disposed of by solution, is by throwing off a number of films in rapid succession, which are taken up by the water as fast as they are formed. In this way, a repellant action exists all round the disk, which action is at first tolerably equal in all directions, but by exposure to the air certain points of the edge of the disk become resinified and cease to give off films. The latter phenomenon then determines a very remarkable set of currents, which may be easily demonstrated by the employment of lycopodium.—Vide *Chemical News*, August 6.

How to Increase the Constancy of Daniell's Battery.—This is effected according to Secchi's plan, by the use of fine sand or sulphur in the porous cell. Its action is accounted for by M. Secchi on the supposition that when the ordinary liquid alone is used, there is greater liability to local action taking place upon the zinc. In a battery, the circuit of which is closed for two minutes every quarter of an hour, M. Secchi has used an ordinary piece of commercial sheet-zinc half a millimetre in thickness, which has continued in action for more than six months without showing the least sign of corrosion. For large elements, he uses, instead of porous diaphragms, bags made of coarse linen cloth coated with a luting of flour and lime. It is thought that these modifications must prove exceedingly useful in practice.

A Thermo-Spectrometer. — Mr. Crookes, the distinguished editor of the *Chemical News*, makes the following remarks in reference to the propriety of devising a new instrument of the above character: Physicists now require an apparatus which will enable them to examine and map out the thermal lines of the spectrum as accurately as this can be done with the visible or philographic portion. With heat radiations of tolerable intensity this would not be difficult to effect. A single row of antimony and tellurium bars soldered together at their alternate ends, as in the ordinary antimony-bismuth electro-pile, could be securely cemented to a solid plate of glass and ground perfectly flat. This flat side could then be cemented to a permanent support of glass, ebonite, or other non-conducting material of a suitable nature, and the other side (after removal of the temporary glass support) should be likewise ground down, till the series of bars was no thicker than a card. This side should now be cemented on to the same kind of supporting material as was used for the other side, and the whole securely sealed up at the sides, so as to leave only the ends exposed. The end of this pile would now be in the form of a very narrow line, which might be half an inch or so in length, and would consist of the extremities of ten or a dozen couples of antimony and tellurium bars, each not longer than a pin. The extremities of this battery being connected with a very sensitive galvanometer, the pile, upon being carried along the ultra-end of the spectrum, would instantly reveal when a ray of heat shone upon it, by a deflection of the needle, and the comparative intensities of the thermic rays could at the same time be ascertained by observing the angular distance to which the needle was driven.

Comparison of Twenty Barometers.—M. Marié Davy communicated a note to the *Association Scientifique* of Paris, at its meeting on the 8th of August last, upon twenty aneroid barometers deposited by M. Vaudez at the Observatory. Comparisons of the working of these barometers, continued for three months, show that they are subject to the influence of temperature like the ordinary mercurial instruments, and that in course of time they undergo sensible alterations in the positions of their zero. The displacement of the zero differs, according to the amount of care bestowed upon the construction of the apparatus, from 0·1 to 0·7 millimetres. In one barometer no alteration took place. These alterations indicate the degree of reliance to be placed upon the aneroid barometer. For regular and precise observations, nothing can replace a good Fortin's barometer; but for occasional observations, such as the determination of altitudes, an aneroid barometer may furnish good results, especially when it can be checked by a mercurial barometer. For these purposes, however, the aneroid might, perhaps, be graduated arbitrarily, and furnished with a comparative table.—Vide *Reader*, Sept. 10.

The Employment of the Pendulum in the proposed Trigonometrical Survey of India is very strongly urged upon Government by General Sabine and Sir C. Wood. In fact, there seems now to be very little doubt that in the projected survey the pendulum will be made frequent use of. The Royal Society is ready to supply the requisite apparatus (pendulums, clocks, &c.), so that the survey will not be put to much additional expense.

The Heat of the Sun.—M. Magnus concludes, from the following experiments, that the sun's heat cannot be derived from a photosphere composed of gas or vapours:—If soda is introduced into a non-luminous gas flame, the latter becomes luminous, and has its heat-radiating power intensified. Although the flame must have lost heat in vaporizing the soda, it still emits one-third more heat than it at first possessed. If a platinum plate be introduced, the evolved heat is of even greater intensity. When soda is added to the platinum, the heat is still higher, and if soda be placed both above and below the metal, the heat emitted is *three* times as great as that given off by the isolated flame. From this fact it follows that solid bodies radiate far more heat than gaseous ones, and hence M. Magnus's generalization.

Sun and Star Light compared.—Mr. Alvan Clark lately made some interesting experiments on this subject. The sun-light was admitted through a vertical aperture, received by a prism and then reflected horizontally into plano-convex lens. The image of the sun thus formed was then viewed at a distance of 230 feet, its diameter being reduced 93,840 times; under these conditions its illuminating power was rather less than α Lyra. After making allowance for the quantity of light absorbed by the various portions of the apparatus, Mr. Clark concluded that if our sun was removed 103,224 times his present distance, his light would not be greater than the star alluded to. Now, as such a distance is not half so great as that of the nearest fixed star, it is evident that our sun must be a small body when contrasted with the other solar bodies scattered through the universe.

The Production of Smoke-rings.—The following very detailed account of the mode in which smoke-rings are formed has been given by Mr. Tomlinson:—The ring of smoke, like the liquid ring, acts as if rolling up or down the inside of a hollow cone, and the direction of rotation of the particles will be found according to this view. In both cases the tendency of the ring is constantly to enlarge by diffusion, and the rate at which it does enlarge is regulated by the resistance of the liquid column, or of the air. The resistance of the liquid column is much greater for the liquid ring than of the air for the smoke-ring; hence the liquid rings do not expand much, while the smoke-rings expand greatly. But the resistance, whatever its amount, must clearly be applied to the outer surface of the ring; or the ring may be said to bear on the surrounding medium by its outer surface, which would be equivalent to its rolling up the inner surface of a hollow cone.—Vide *Philosophical Magazine*, June.

Causes of Error in determining Specific Heats.—These, according to Dr. Hermann Kopp, are three in number:—

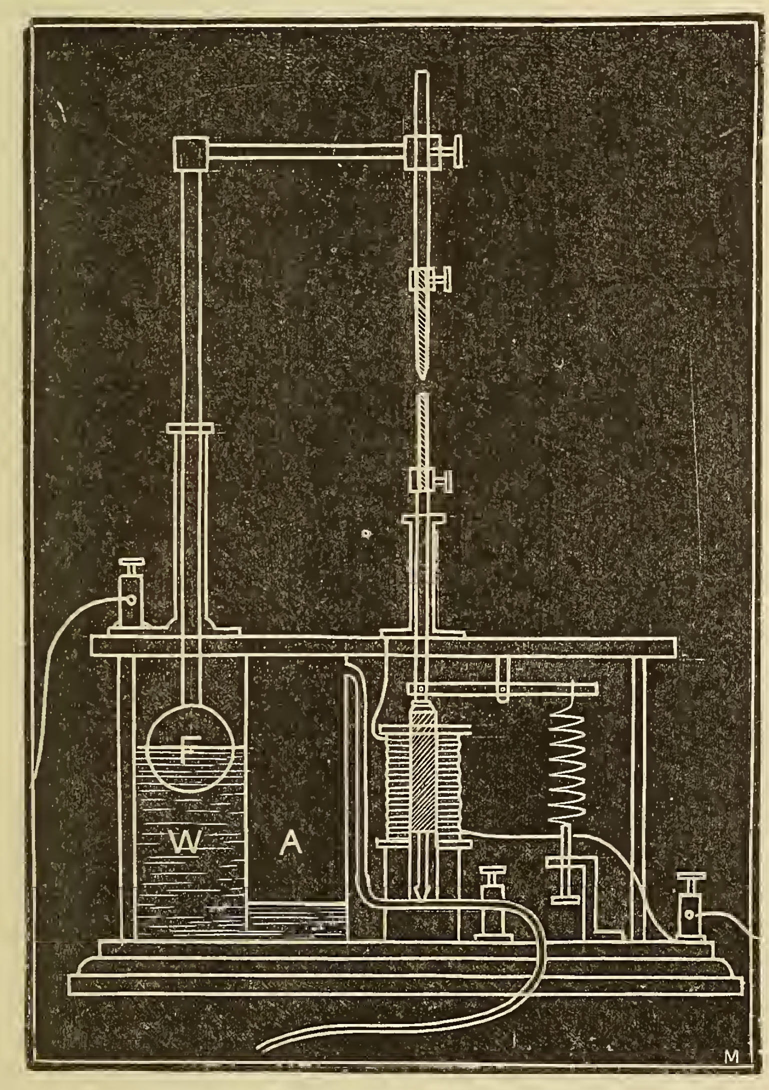
(1.) When the substance is heated to a temperature at which it begins to soften, in which case it absorbs part of its latent heat of fusion.

(2.) When the substance is heated to a temperature at which it begins to pass into another modification, and this change, with its accompanying development of heat, is continued in the calorimeter.

(3.) If the substance investigated is porous, and (as was the case in the earlier methods) is directly immersed in the liquid of the calorimeter, in which case the development of heat which accompanies the moistening of porous substances comes into play.—Vide a Paper read before the *Royal Society*, during the past session.

The Examination of Minerals with the Spectroscope.—In the last number of the *Dublin Quarterly Journal of Science*, we find an important paper on the subject of spectrum analysis, from the pen of Mr. Emerson J. Reynolds. Contrary to the opinion of Kirchoff, that the spectra of a combination of salts are as distinct as the same when viewed separately, Mr. Reynolds declares that it can be easily shown that the spectrum afforded by a mixture of salts depends to a great extent upon the relative proportions of the constituents of the mixture. If a chloride of any metal of the alkalies or alkaline earths be introduced into the flame of a Bunsen's burner, it almost immediately commences to volatilise. The alkaline chlorides being more volatile than those of the alkaline earths, are first completely dissipated in vapour. Chloride of lithium is but little less volatile than chloride of sodium. In Bunsen's experiment (from which Kirchoff's conclusion was drawn), the quantities of the various chlorides composing the mixture were about equal; thereupon the order in which the several spectra appeared seemed to indicate the relative degrees of volatility of the different chlorides. The sodium spectrum appeared first, and as it faded the lithium spectrum became visible; but since the volatility of the lithium salt is but a little below that of chloride of sodium, some of the former must have volatilized with the first portion of sodium vapour, though it escaped detection. It was only when the sodium light diminished in intensity, that the lithium spectrum made its appearance, together with the spectra of potassium and barium. Hence the conclusion is inevitable, that "if a sufficiently large amount of sodium were present in proportion to the chlorides of other metals, no spectrum but that of sodium would be obtained, and we should therefore fail to detect lithium or potassium, though they were actually present." The only remedy which Mr. Reynolds proposes is the employment in doubtful cases of the inductive spark.—Vide *Dublin Quarterly Journal of Science*, July, 1864.

Cheap Electric Lamp.—Mr. S. Highley, the philosophical instrument-maker of Green Street, Leicester Square, has just constructed a novel form of automatic regulator for the electric light which strongly recommends itself to the notice of the lecturer and experimentalist, as it is exceedingly sensitive in action, simple in construction so as to be little liable to get out of order, and very cheap, as with a sufficient number of cells of a new modification of battery it can be sold at a price that is usually charged for a Duboscq's or Serrin's regulator, *per se*, without battery power. The manufacturer of this arrangement calls it Malden's Pneumatic Electric Regulator, being indebted to that gentleman for the novel principle of construction. A sectional view of the part is shown in the adjoining figure. The rod that supports the upper carbon is attached to a copper float, F, that rests upon a column of water, W, contained in a chamber that communicates by a small opening with an air chamber, A, after the manner of Tilley's blow-pipe; from the upper part of this air chamber passes a small pipe terminated by a flexible tube of vulcanized rubber, that is carried under a wedged shaped piece attached to the end of a rod that carries the lower carbon; a portion of this rod is constructed of soft iron, which part passes through the centre of a hollow coil of stout insulated copper wire. The action is as follows: when the wires from a battery are connected with the respective poles of the regulator, and the carbons are brought into contact, the current passes through the arrangement and the coil becoming magnetic, pulls down the iron core, separates the carbons so as to produce the proper arc of light, and at the same time forces the wedge down upon the flexible tube and closes it as effectually as a stopcock, so that no air can escape from the air chamber. As soon as the distance between the poles becomes too great for the current to pass freely, the coil ceases to be magnetic and the lower rod is raised slightly by the action of a lever and counterpoise spring; immediately air is forced from the chamber, A, by the action of the column of water in W, the float, F, sinks and consequently brings the upper carbon down in contact with the lower one; *instantly* the circuit is again completed, the coil becoming magnetic pulls down the iron cone, presses the stopcock wedge upon the rubber tube, no more air escapes and the upper pole is arrested in its descent, and remains



stationary till "the striking distance" between the poles again becomes too great, when the above described action is again repeated; but beyond this, when the current between the carbons begins to weaken, an oscillating action commences, and as small portions of air, in consequence, escape from the tube, the upper carbon supporting-rod is gradually lowered, so that it will be seen the action is perfectly sympathetic, for as the carbon burns away, they are gradually brought nearer to each other by this compensating power, and if a piece of either of the carbons break off, so that "the striking distance" by such an accident becomes too great, the poles are immediately brought into contact and the light reinstated. In place of the Tilley blowpipe arrangement, a simple air-cushion and springs may be employed, but Mr. Highley thought the first to be less liable to disarrangement through changes of temperature. There are other points of detail, which, however, are not necessary for a comprehension of the principle of action of this electric regulator.

ZOOLOGY AND COMPARATIVE ANATOMY.

Structure of the Thumb in Apes.—This subject, which has had such an important bearing upon the semi-theological discussion as to man's place in nature, has lately received the attention of that distinguished brain-anatomist, M. Gratiolet. This *savan* declares that according to his dissection the differences between the hands of man and apes are far more striking than has been supposed. In the latter the thumb is moved towards the palm by an oblique division of the tendon of the common flexor muscle of the fingers; hence it is drawn in during all movements of flexion on the part of the fingers, and has no intrinsic or special power of motion. The same type of structure is observed in the gorilla and chimpanzee; but the small tendon which should move the thumb, is reduced in these species to a mere tendinous thread, which has no action, for at its origin it is lost in the synovial folds of the flexor tendons of the other digits, and it does not terminate in a muscular fasciculus; the thumb therefore has its typical power very much diminished in these animals. In none of them is there the faintest trace of that powerful and independent muscle which moves the human thumb, and, so far from being of a complete form, this phalanx (so characteristic of the human hand) appears in the highest of these Apes—the Orangs—to have a tendency to atrophy.—Vide a paper read before the French Academy, August 17.

The "Spontaneous Generation" Controversy.—Among the latest disputants of M. Pouchet's favourite doctrine, we may mention the name of M. Coste, the celebrated embryologist, and advocate of oyster culture. He insinuates that the microzoa (infusoria), which M. Pouchet supposes to have been developed spontaneously, were derived from external sources, and travelled through the filters which were employed as barriers; but M. Pouchet makes a very apt reply to the effect that, according to M. Balbiani's measurements, the diameters of the ciliated infusoria which he produced are far greater than those of the porosities observed in filter-paper. He admits that a few infusoria pass through, but denies that any of these are ciliated. The microzoa which he has produced arise from spontaneous eggs which are developed in decomposing matter. The spontaneous ovum is clear, transparent, and filled with extremely fine granules; it is smaller than even an encysted microzoan, and presents at first no traces of internal organs. After having remained stationary for some time the vitellus at length commences a series of gyrations, and these are seen to occur beneath its envelope which is deprived of cilia. After a while one sees the *punctum saliens* which is characterised by rhythmic movements, and must not be confounded with the heart of encysted microzoa. Finally, embryonic movements make their appearance and the young animal springs from the egg. M. Pouchet ridicules M. Coste's notion that the *contractile vesicle* is an aquiferous propelling organ; for, says he, if this were the case, why should an infusoria which is encysted, and hence cut off from all connection with the surrounding element, possess this body? He terminates his memoir with the following conclusions:—

1st. If ciliated infusoria are accidentally introduced into an experimental maceration, they play no part in the operations of heterogeny.

2nd. Such infusoria are destroyed by the very first processes of fermentation which are set up in the liquid.

3rd. The pellicle on the surface of macerations is a genuine *proligerous stroma* for the development of ciliated microzoa.

4th. When the stroma is undeveloped no infusoria will be formed.

5th. Neither the ciliated infusoria which have been experimented on, nor their cysts, nor their ova, ever travel through the filter.

6th. The multiplication of infusoria does not take place by fission to the extent that has been imagined.

Re-distribution of the Genera of the Order Ruminantia.—It seems a pity that zoologists do not base their classification upon peculiarities of internal structure, rather than of external form. That a scheme of arrangement on the latter foundation is occasionally unsound, has been shown by M. Milne Edwards. He contends that the musk deer are truly cervine, and that the presence of canine teeth is not confined to these species, which, on the other hand, have the stomachs and uterine apparatus of the deer-tribe. He also considers that the genus Tragulus does not belong to the Ruminant order at all, and ought to be ranked among the Pachyderms, for it has but three stomachal cavities, and the placenta is diffused over the entire surface of the uterus, and not limited to certain portions, as in the Ruminant group.—Vide *Comptes Rendus*, No. 6.

Pisciculture in Brussels.—The experiments which have been in process of being carried out in the latter city during the past five years, have been attended with the most satisfactory results. The ova which were originally sent from the well-known establishment at Huningue, have not only reached a state of development seldom attained under natural conditions, but have deposited both milt and ova; and these in their turn have given rise to an enormous development of young fish, so great, indeed, that the authorities have been quite taken by surprise. We understand that some of the trout removed from the ponds last November, weighed as much as 8lb. This looks promising, and must prove encouraging to those who, in opposition to numerous difficulties, are endeavouring to introduce fish-culture into these countries.

A New Classification of Birds to be based upon the principles of morphology has been proposed by M. Segoud. He has already constructed a classification of mammalia upon similar foundations. The taxological arrangement of birds would, he conceives, be somewhat more difficult. The characters selected in the mammalian scheme are those of the vertebral column, but as the spine of birds is subject to less modification than that of mammals, he sums up the total characters of the skeleton in classifying the former, which he ranges under *four* natural orders.

The Colour of Corals.—Some very interesting observations on this subject have been made by M. Lacaze Duthiers, who was sent out by the French Government to study the development of the Mediterranean corals. This naturalist affirms that the colours of the coral, as we know it, and as it exists in the ocean, are in some instances quite different. Thus, he says, *Gorgonia subtilis*, when taken from the sea, is of a lovely orange red hue, but in most writings it is described as being white. The *Muricea placomus*, which is also orange, when in its native element, is represented as being of a blackish colour. These differences owe their origin to the circumstance that, in some corals, the colouring matter is deposited in the soft tissues, whilst in others it exists in the harder parts. In the first case, the cells which compose the Sarcosome or walls of the polyps' bodies, are filled with minute granulations, which produce the characteristic tint; but this matter is of a very delicate character, and on exposure to air or fresh water it becomes altered. In the second case, the granulations being in the hard calcareous substance, the colour is enabled to resist external influences.

Action of the Cicatricule of the Egg.—The researches of Quatrefages and others have shown that the ovum possesses peculiar powers which are quite independent of the properties developed after contact with the sperm. Thus it is now known that the vitellus undergoes segmentation, whether the ovum have been impregnated or not. But recently a new fact has been discovered by M. Dareste, who finds that *the cicatricule does not share in the general process of segmentation, unless there has been contact of the ovum with the zoosperm.*

Progress of Agassiz's Museum.—Professor Agassiz is certainly accumulating a monster collection of natural history objects. During the past year no less than 73,000 specimens of animals have been added to the museum. But this is not all; of those animals which, from their minute size and delicacy of structure, it is impossible to exhibit specimens, enlarged and accurate diagrams are made and placed in conspicuous localities. The Professor writes: "Many hundreds of these diagrams have already been made by my friend Mr. Bourkhardt, some of which are now on exhibition in the museum; and in a few weeks every available space in our public rooms will be occupied by those which have thus far remained in portfolios. This will greatly add to the interest of our collections, and form a novel feature in the museum, which I have no doubt will soon be imitated by others." The Government of Massachusetts has already given the museum authorities a sum of 10,000 dols. for an illustrated catalogue, which we believe is now in the press.

Habits of the Ant.—Few of our readers may be aware that the ant delights to capture the *aphis*, and domesticate it for the sake of the saccharine matter which exudes from its abdomen. This fact was long since pointed out by that greatest of all observers in natural science, Huber, who also affirmed that the ant went so far as to build habitations for the aphides. The latter statement has always been received with a great deal of doubt, but now Mr. J. Swain, of Philadelphia, has come forward to corroborate (unintentionally) the assertion of Huber. Believing that he is the first who has observed these peculiar habitations, he has transmitted specimens of them found on the branches of *Vernonia noveboracensis* to the French Academy. MM. Edwards and Blanchard, to whom they were committed for examination, admit the correctness of Mr. Swain's observations, but assign to him only the merit of having discovered that the American ants have similar tastes for luxury to those of their European relatives.—Vide *Comptes Rendus*, Aug. 1.

The Geographical Distribution of Annelids.—M. De Quatrefages has just completed his great treatise on the Annelid group and its distribution, and has drawn the following conclusions as to the manner in which the members of this class are spread over the globe :—(1) The class of Annelids properly so called (*Errantes* and *Tubicola*), has the same area in salt water as the earthworm and naïs have in fresh water. (2) The former division (to which alone M. De Quatrefages applies the term Annelids), has representatives in every sea. (3) This wide range seems to extend to the more typical genera of this class, as well as to the most exceptional sub-types. (4) Hence the Annelid fauna presents no division into *zoologic regions* or centres of creation, which in other classes are so well marked out. (5) The tendency to the diffusion of genera and sub-genera is counterbalanced by the tendency to the localisation of species. (6) The number of similar species inhabiting the two continents, if not represented by cypher, must always be extremely limited. There is but one species common to the French and Mediterranean shores. (7) The few exceptions to the law of localization of species may be explained by reference to the action of marine currents. Thus it was that I found Rousseau's large *Eunice* at Saint-Jean-de-Luz, a species which Cuvier confounded with the great Eunice of the Indian seas. This worm, which belongs to the Antilles, had evidently been carried by the current of the gulf-stream from the coast of Mexico. (8) From the wide area of distribution possessed by the types, and the localisation of the species, it follows that we must not look for corresponding geographical limits in the latter. (9) The Annelid class does not present elevation or degradation of organisation in accordance with latitude, a phenomenon which is exceedingly well marked in other groups, as the crustacea, for example. Equality of organisation is one of the most constant laws regulating this group of beings. (10) The nature of the coast line influences the development of the Annelid fauna to a great extent : thus on granite and schistose shores, the number of species and individuals is large, whilst on calcareous coasts it is correspondingly small.

Phenomena observed during the Death of Sponges.—Herr Lieberkühn has found that during the decay, or rather death of the sponge, it sends out a series of peculiar prolongations which travel over the siliceous skeleton, and at length find their way to the bottom of the vessel and develope spicules and cilia. He also states that dying sponges frequently divide into particles whose structure and characters are not to be distinguished from those of the parent. Whether these be original discoveries or not remains to be shown, but it seems to us that the process described by Herr Lieberhühn is very similar to the ordinary mode of development of spongilla, which has been so carefully studied by Carter and others.

The Anatomy of Anodonta.—In the *Intellectual Observer* for September we find an important paper on the structure of the swan mussel (*Anodonta cygnea*), by the Rev. W. Houghton, who points out some interesting peculiarities in the arrangement of the parts composing the so-called *crystalline style.* The latter body is a cylindrical transparent semi-cartilaginoid mass of tissue which fills a long cœcum that extends from the lower part of the stomach through the convolutions of the intestine. This body, which is absent in all uni-muscular bivalves save Anomia, is not confined to Anodonta and Unio among dimyaria, as Mr. Houghton appears to conclude upon the authority of the late M. Moquin-Tandon. It has been found by Siebold and others, in Pholas, Solen, Arca Mactra, Donax, Cardium, and Tellina. Siebold describes the style of Anodonta as being composed of two distinct portions, a cortical and medullary. "The first, which forms a kind of tube, is homogeneous, transparent, and formed of concentric layers of the consistence of the white of an egg. The second is equally homogeneous and transparent, but is of a more gelatinous nature and contains *a quantity of small batons* insoluble in acid, which at the points where most aggregated, give this organ a whitish colour when examined by reflected light." Mr. Houghton's paper, while it does little more in other respects than recapitulate the results of other observers, has afforded us some very interesting information regarding the microscopic structure of this "style." He finds it "to contain embedded within its substance, large numbers of a very minute filiform animalcule, which may be seen under the microscope to shoot backwards and forwards in the gelatinous mass. I have failed hitherto to make out any structure in these curious parasitic vibrioid worms." Fact is always valuable, hypothesis is frequently objectionable, and while we think there is every credit due to Mr. Houghton for the important observations he has made, we must certainly say it would have been wiser to have reserved judgment concerning the nature of the peculiar structures observed. Till further evidence is advanced, therefore, we must remain in doubt as to the exact character of Mr. Houghton's "curious *parasitic vibrioid worms.*" It is strange that neither Poli nor Bojanus should have observed these bodies, but possibly their instruments were not sufficiently powerful. The memoir of the latter, which is to be found in the *Isis* for 1827, is of a very meagre and unsatisfactory character, and the figure of the style (Crystal-Griffel) represents it as being a talc-like plate of about a quarter of an inch long, of a somewhat triangular outline, and one of whose sides is irregularly serrated.

The Structure of rare Corals.—In a recent number of the *Comptes Rendus* we find a memoir of M. Lacaze-Duthiers, upon the structure of two species of *Antipathes*, *A. sub-pinnata*, and *A. salix.* These are, of all species, the most difficult to study, and this is why we know so little about them. They live at immense depths, and are never taken by the ordinary coral-collectors. They are formed of so delicate a tissue, that the shortest exposure to the air causes it to wither and disappear; and as it is extremely difficult to induce the fishermen to place and keep them in sea-water during their trip, the study of them becomes no easy matter. In the former of these two species, M. Lucaze-Duthiers found only two of the visceral septa, which are so characteristic of all other corals.

BRITISH MUSEUM
NATURAL HISTORY.

Pl.VI

Fig. 1

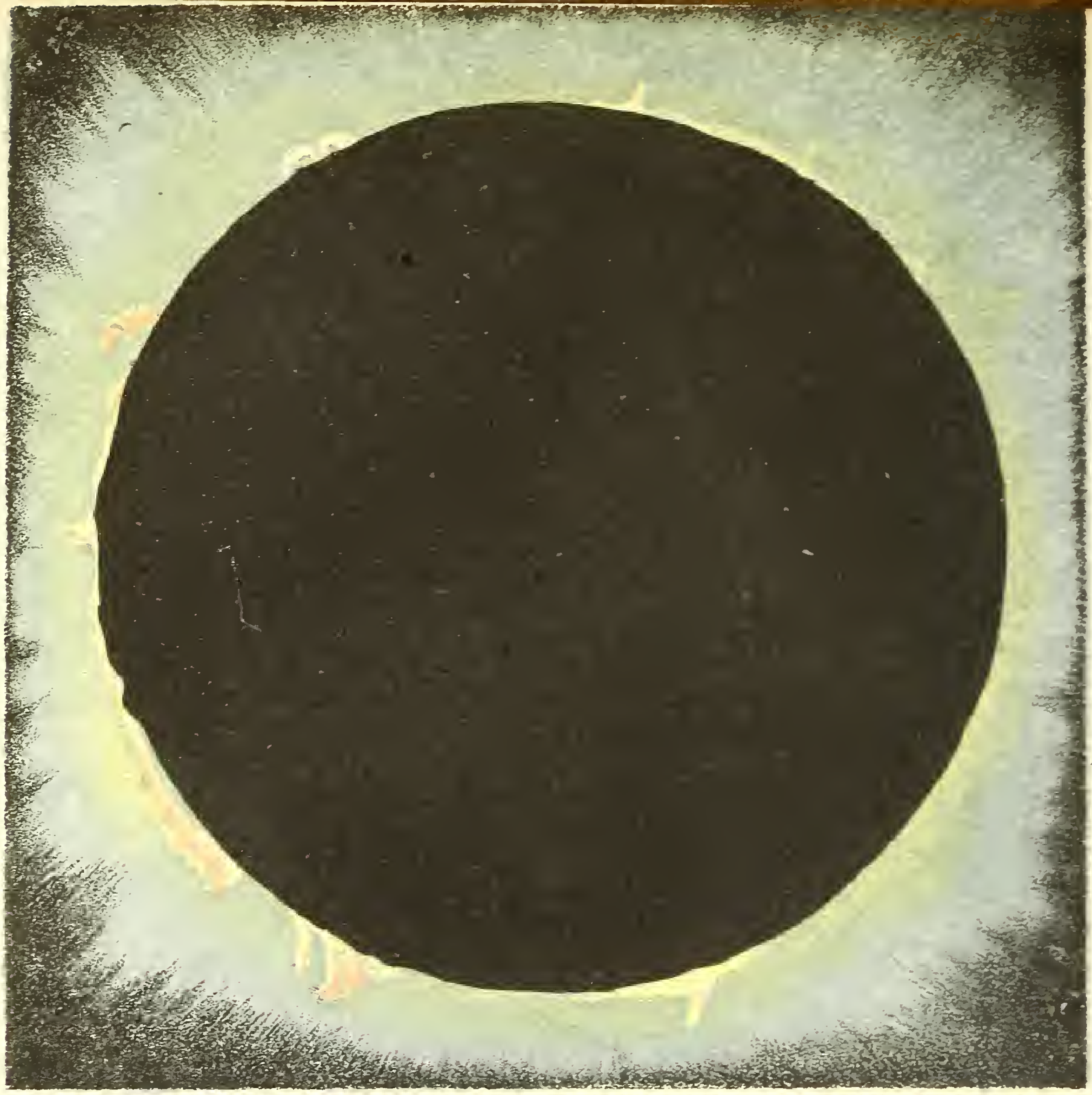
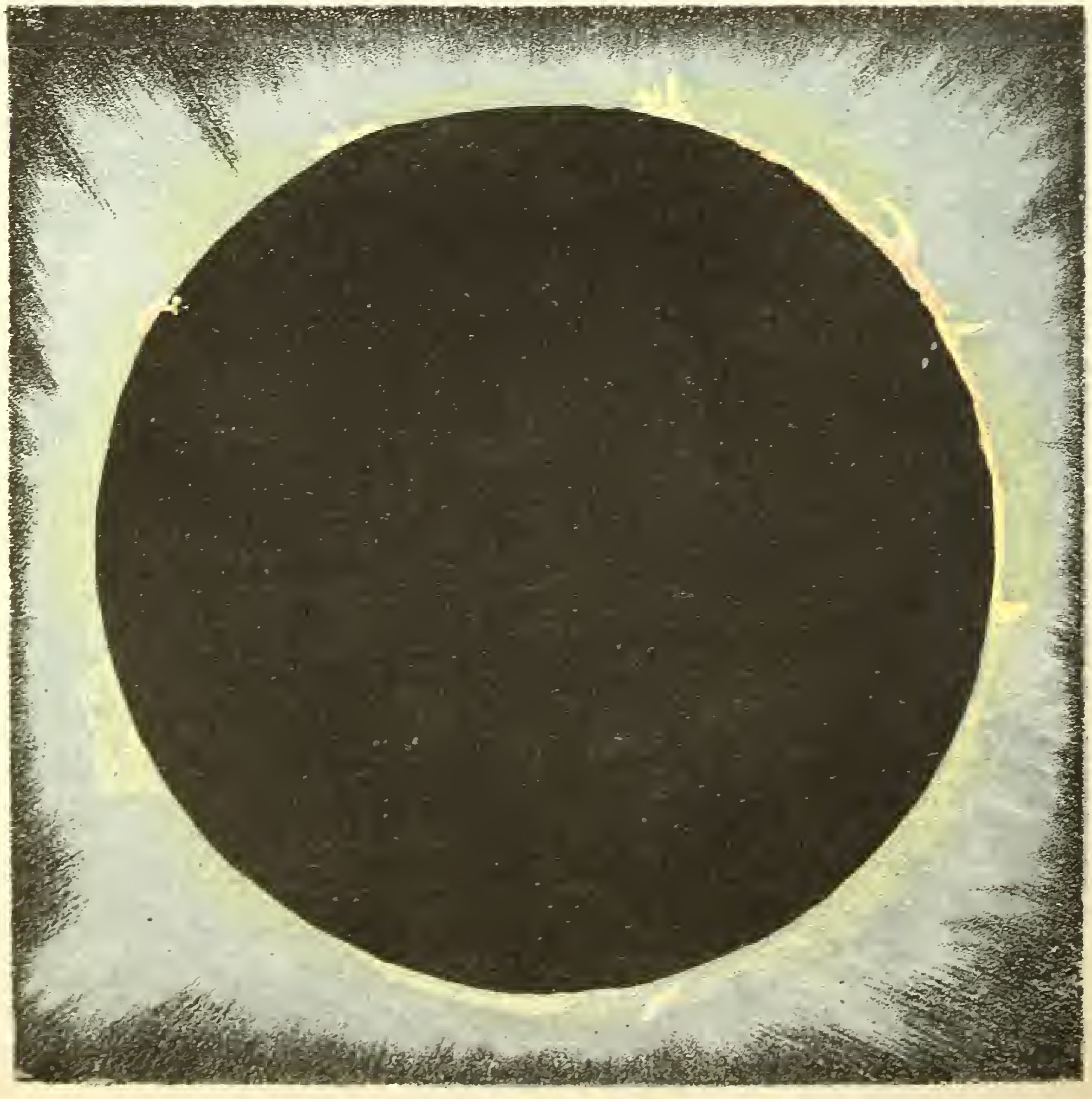


Fig. 2



THE SOURCE OF HEAT IN THE SUN.

BY ROBERT HUNT, F.R.S.

INDUCTIVE science, moving hand in hand with deductive philosophy, is rapidly adding to the stores of human knowledge. By experiment and by observation, facts are rapidly being accumulated, and the powers of the mind are ever active in interpreting their significations. No department of science has been more productive of new and great truths, tending to enlarge our mental vision, than that division of physics which has taken the Sun and its radiations for the objects of investigation. It may be that some of the phenomena observed will eventually receive a different solution from that which they now receive, and it is probable that some of the hypotheses which have gained the approval of the most thinking minds, will give place to others; but certain it is that we are placed, with improved perceptions, upon an elevated spot, and our horizon is vastly enlarged. The mind of man, over-reaching the immensity of space between this little planet and the giant Sun, to which it is chained, lands upon the solar surface and investigates its phenomena. It is by no system of vague guesses that we proceed upon this inquiry: every step in advance is secured upon a well-determined fact; and each hypothesis by the light of which we are guided, is the result of the profound study of observed phenomena. In this brief essay, we shall endeavour to give all the evidence which is of importance, as leading to the conclusions to which modern philosophy has arrived, respecting the constant renewal of the solar energies.

Our inquiry into the origin and support of solar heat involves a consideration of the sources also of the luminous and the chemical (*actinic*) powers—since these are associated with calorific force in the sunbeam—and are, without doubt, developed by the operation of the same causes. Nor must it be forgotten that those electrical manifestations, which are familiar to us in the phenomena of terrestrial magnetism, are evidently connected with solar perturbations.

By the operation of some peculiar exciting powers, the solar energies are developed and radiated from that great centre in all directions through space. For a long period it was supposed by all who bowed before the shrine of Newton, that material particles of infinite tenuity were launched forth from the Sun, and travelled at the rate of nearly 200,000 miles in each second of time towards the earth and the planets. But now, in the place of the theory of emission, we have the theory of undulations. This view supposes the existence of an infinitely elastic ethereal medium filling space, and interpenetrating all forms of matter. A disturbance originating on the Sun sends a wave forth from its shores, the pulsations of which are presently felt on the shores of this island, Earth, which floats at a distance of 91,328,600 miles in the ethereal ocean. According to the rate of these pulses—or, rather, according to the vibratory excitation which they produce in matter—so the senses recognize heat or light, and either chemical or electrical phenomena are manifested. A bell, says Mayer, is sounded in the Sun, and its notes are sensible upon the Earth and all the planets. Presuming that it will be allowed to be, at all events, probable that like effects are the results of like causes, and that the development of heat and light on this planet presents some analogy to operations which are ever active in the Sun, it will elucidate our subject if we briefly examine the evidences afforded by the terrestrial (artificial) production of heat and light.

A body at rest shows no increase of temperature. If it is screened from the influence of heat radiations, it remains,—in ordinary language,—cold. If the mass of matter be set in motion, its temperature rises. This is familiarly proved by rubbing a metal button on a piece of cloth or on a board, when the heat is determined by the friction—resistance to motion—to which it is subjected. A body falling through empty space—a void—would not acquire heat, because there would be no disturbance of its particles; but if suddenly stopped in its fall it would be subjected to a disturbance, equivalent to the velocity it had attained, and a certain increase of heat would be the result. A rifle-ball in passing through the air, is heated by the resistance offered to its passage, and its velocity being known, it is easy to calculate how much heat it will acquire in its flight. Dr. Joule has determined that the heat generated by a body falling through the air is proportional to the height through which it falls—that the quantity of heat which would raise one pound of water one degree Fahr. in temperature, is exactly equal to what would be generated if a pound weight, after having fallen through a height of 772 feet, had its moving force destroyed by collision with the earth. The application of this will by-and-by be seen.

By mechanical attrition, so large an amount of heat may be produced, that the body, if metal, will become incandescent; if wood, it will take fire. Now, this is regarded as the conversion of motion into another form of force—heat; and hence the hypothesis that heat is a mode of motion. There are several modes of motion, but in all of them the relation of heat to the disturbance and the resistance obeys the same law. The law of equivalents is unvarying. The same quantity of the electric fluid which passes through a *good* conductor such as copper wire, without producing any sensible increase of temperature, is developed as heat and light in passing through a *bad* conductor such as platinum, the obstruction offered to its motion determining the result. Chemical action, again, produces motion amongst the combining particles, and according to the rapidity of combination, so is the intensity of the calorific or luminous effects produced. It is not possible to pursue this subject, notwithstanding its interest, any further in this place, since other matters claim our close attention.* The law of equivalents to which reference has been made, prevails in all the operations of nature. Not merely is the equivalent of heat and light produced, determined exactly by the amount of motion established and converted into force, but an exact quantity (an equivalent) of matter undergoes a change of form in the production of any physical effect. In the ordinary processes for producing heat or light, carbon is the element upon which we depend. Whether we employ coal or wood in our common fires or our furnaces; whether we use candles, animal or vegetable oil, or paraffin, or gas, as the illuminating agent, the quantity of carbon present regulates the result. For the moment, the hydrogen in combination is neglected, as tending to complicate the explanation; the result is, however, precisely the same. The solid carbon in any of the substances named is brought in contact with a burning body, and it begins to burn—that is, it seizes oxygen from the air, and in accordance with the energy with which this seizure is made, so is the intensity of the result. The quantity of heat or of light given out is measured by the rapidity with which oxygen enters into combination and forms carbonic acid, or an oxide of carbon. To take another illustration, the metal magnesium is drawn into wire, and it does not oxidize (tarnish) readily under ordinary circumstances; but ignite it in a flame, and it seizes oxygen with such avidity, that an intense heat is generated, and the pure white particles of magnesia formed become so *hot* that they glow with the utmost intensity of light. In either of the examples given, the degree of excitement produced (the rate of motion attained) determines the physical effect, and by employing the heat thus developed to do work, we obtain from it the same equivalent of motion, less the loss which arises from the imperfection of our means for employing the ethereal spirit, Heat, to work like a slave in chains.

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* The reader who is desirous of examining fully the whole question, is referred to "Heat considered as a Mode of Motion," by John Tyndall, F.R.S.

In some previous articles * the physical conditions of a sunbeam have been examined, and the beautiful results dependent upon the cautious observation of the solar spectrum (spectrum analysis) described. Not only this, but the relations have been shown between the spectra obtained from artificial flames, the composition of their burning matter being known, and the solar spectrum, the composition of the Sun's burning matter being previously unknown. The result being that it has been determined, with quite as much certainty as any other discovery depending upon human sense, that the conditions under which we can produce certain phenomena in the spectra of artificial flames, are actually the conditions under which we obtain the solar spectrum with its remarkable black lines. This, therefore, leads us to a knowledge of much that is going forward in the Sun; and it enables us to assert, with good presumptive evidence in favour of its correctness, that heat originates in that mighty orb under like conditions to those with which we are familiar; that the solar radiations themselves afford us the evidence that they are the result of chemical or physical changes, like those which produce heat and light upon this earth.

It becomes necessary now that the present state of our knowledge of the physical constitution of the sun should be examined. It is regretted that it is not possible to give the steps by which discoveries have been made, or to discuss the claims of all the numerous laborious observers to whom we are indebted for them. A general review of the subject is all that our space allows, and the high claims of those astronomers whose names appear not in this article are by no means disallowed. When the Sun is viewed through powerful telescopes, its surface—that is, the luminous envelope of the mass—is seen to have a peculiar mottled or curdy appearance. Arago proposed that this envelope should be called the *Photosphere*, a name now generally adopted. By the elder Herschel, the surface of this photosphere was compared to mother-of-pearl. Other astronomers have said that it resembles the ocean on a tranquil summer day, when its surface is slightly crisped by a gentle breeze, and an undulating play of light is reflected from these little billows.

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* Popular Science Review, Vol. I. p. 205 and p. 438. *See* also "The Sun and Solar Phenomena," p. 299.

Irregular lines of light are sent back from the crests of the small waves, and lines of shadow indicate the hollows. Within the last few years Mr. Nasmyth has discovered a more remarkable condition than any that had previously been suspected. Examining the solar surface with a fine telescope of great penetrating power, this astronomer has discovered objects which are peculiarly lens-shaped. He himself describes them as more like "willow leaves" than anything else; but some other observers, since their discovery, have likened them to rice grains; and others, again, to some forms of Diatomaceæ. These leaved forms are different in size; they are not arranged in any order; they lie crossing each other in all directions; and they have an irregular motion amongst themselves. They are, says Mr. Nasmyth, "arranged without any approach to symmetrical order in the details, but rather (if the term may be used) in a sort of *regular random scattering*." They are seen approaching to and receding from each other, and sometimes assuming new angular positions, so that the appearance, resulting from the combination of simultaneous motions amongst those forms, has been compared to a dense shoal of fish, which, indeed, they resemble in shape. Plate VII., which we have given, conveys a good notion of this. The size of those objects gives a grand idea of the gigantic scale upon which physical operations are carried out in the sun. They cannot be less than a thousand miles in length, and from two to three hundred miles in breadth. The most probable conjecture which has been offered respecting those leaf or lens-like objects, is that the photosphere is an immense ocean of gaseous matter in a state of intense incandescence, and that they are perspective projections of the sheets of flame. Whatever they may be, it is evident they are the *immediate sources of solar heat and light.* Here we have a surrounding envelope of photogenic matter, which pendulates with mighty energies, and by communicating its motion to the ethereal medium, in stellar space, produces heat and light in far distant worlds. We have said that those forms have been compared to certain organisms; and Herschel says, "Though it would be too daring to speak of such organizations as partaking of the *nature of life, yet we do know that vital action is competent to develope heat, light, and electricity.*" Can it be that there is truth in this fine thought? May the pulsings of vital matter in the central Sun of our system be the source of all that life which crowds the Earth, and without doubt overspreads the other planets, to which the Sun is the mighty minister?

Attention must now be directed to other indications of solar activity, which will at the same time make us acquainted with physical conditions which differ from those of the luminiferous photosphere. Dark spots on the sun have been constantly observed from the time of Galileo to the present, and for a long period a careful record of their appearances and numbers has been kept. A dark spot may be described as commencing in some minute pores or dots upon the brilliant solar surface. These increase; by some they have been thought to have a visible motion. They assume an *umbral* blackness, and acquire at first an irregular and changeable shape. These conditions will be understood from the accompanying woodcut (fig. 1), from a drawing by Mr. Carrington, of a group of spots observed on the 8th August, 1860.* When these have attained some measurable size, a *penumbra* begins to be formed, which is, as Herschel says, "a circumstance strongly favouring the origination of the spot in a disturbance from below upward." Large spots are always attended by *faculæ*, which are vein-like lines appearing on the photosphere, but still more luminous than it. These are well shown in the woodcut (fig. 2), from a photograph taken by Mr. Warren De la Rue; the associated one (fig. 3) giving—upon the same authority—the condition of a well-formed solar dark spot. It is difficult to convey an idea of the vast size and extent over which these evidences of solar activity spread. Dark spots, covering an area of between seven and eight hundred millions of square miles, are not uncommon. Herschel measured one which "occupied no less than three thousand seven hundred and eighty millions

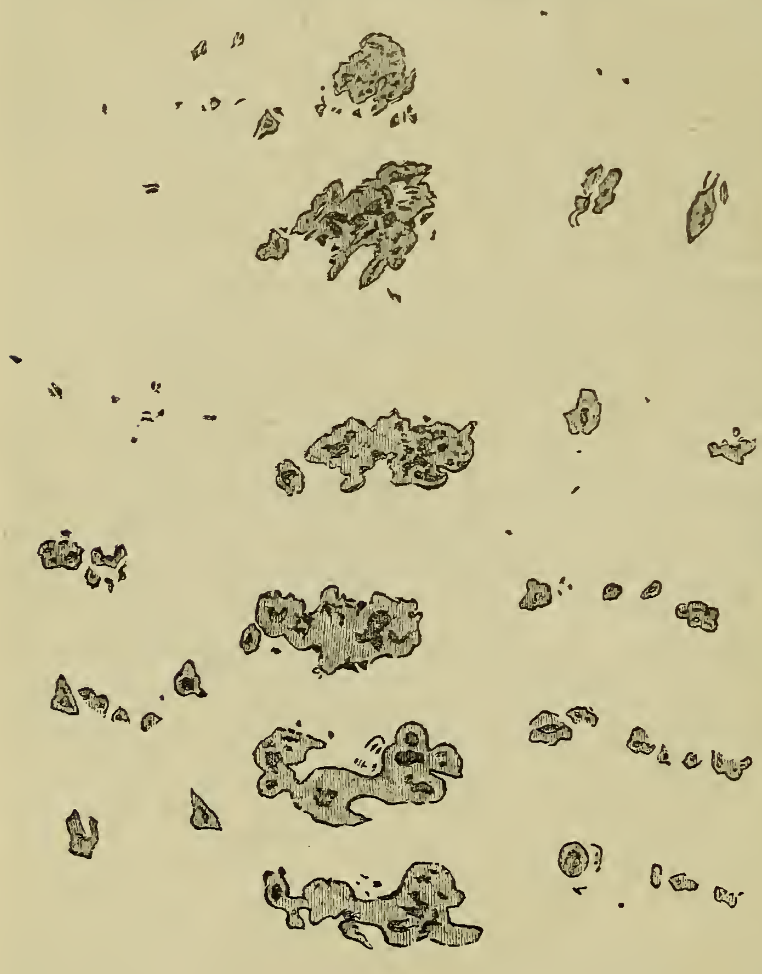

Fig. 1.

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* Observations of the Spots on the Sun from Nov. 9, 1853, to March 24, 1861, made at Redhill by Richard Christopher Carrington, F.R.S.

(of square miles), taking in all the irregularities of its form; and the black space, or 'nucleus,' in the middle of one very nearly round one would have allowed the Earth to drop through, leaving a thousand miles clear of contact on every side, and many instances of much larger spots than these are on record."

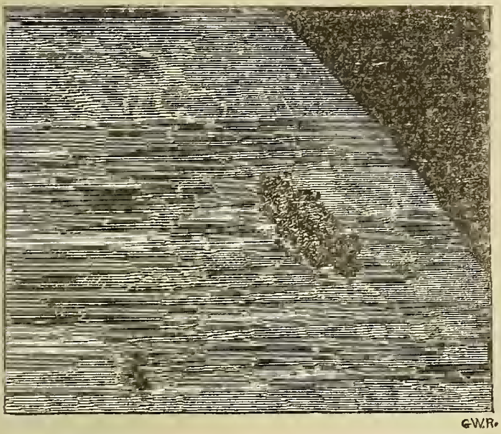

Fig. 2.

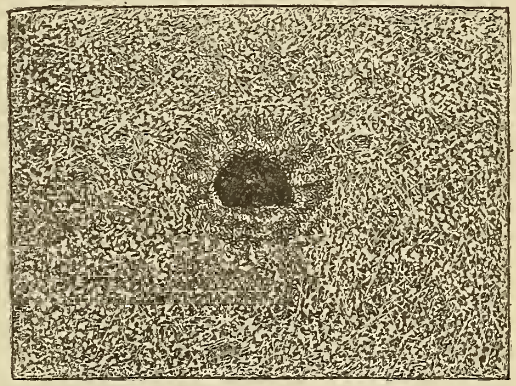

Fig. 3.

The cyclones—the whirling storms of our Indian seas, spreading in their path death and desolation, involving alike fluid and solid matters in the vorticose motions—are but miniature representations of those mighty tornadoes of the Sun. It cannot, however, but be admitted that our great revolving storms do in many respects resemble the phenomena of the formation of the solar spots; and probably, if we could look down upon our atmosphere as we look down upon the photosphere of the sun, we should discover that they had characters much in common. Amongst other things, our great cyclones and tornadoes are limited to a certain zone of the Earth's surface; and the dark spots on the Sun are mainly confined to a zone extending to 30° or 35° in latitude on either side of his equator. We know not of any order of periodicity observed by our terrestrial storms, but observations extending over more than half a century inform us that there is a regular order of increase and decrease in the number of solar spots. In advancing from their minimum to their maximum, and in again descending to their minimum, about—but somewhat less than—twelve years are expended, there being nine complete periods in a century. We have described the photosphere, and attempted to give an idea of its luminous waves. More difficult is it to convey an idea of the breaking up of the lines of light, the crests of the billows, into points, as indicating—may it be called—a boiling from below, and the gathering together of these black dots to open out into a gigantic black space, through which we penetrate the sphere of light, and see into the sphere of shadow or of opaque clouds, and eventually through these into a blackness, which is thought by many to indicate the *dark solid mass of the Sun.* We have indications of still other wonders, and by carefully observing the astounding phenomena which accompany the total eclipses of the Sun, we have in all probability been brought acquainted with the true solar atmosphere extending beyond the photosphere. The great solar eclipse of July 18, 1860, was an opportunity upon which all astronomers seized. The central path of the moon's shadow and the limits of totality having been carefully determined, the English astronomers selected Spain as their base of observation. Mr. Warren de la Rue, armed with well-prepared photographic apparatus and materials, and aided by trained assistants, placed his observatory at Rivabellosa, about two miles from the town of Miranda. From this point, which was most fortunately chosen, a series of photographs were obtained, which confirmed all that had been previously stated of certain rose-coloured prominences, which appear on the edge of the Sun when the total observation is complete.*

The engraving which we have given shows the peculiar forms of these remarkable appearances (Plate VI.). The excrescences assume various shapes, sometimes appearing like mountain ranges, often like gigantic flags streaming upon steady winds; then again they appear like clouds, and not unfrequently assume fantastic shapes, which have been compared to falling trees and to boomerangs. That these belong to the Sun, and not to the Moon, is certain, since the moon in its progress over the Sun gradually *hides* those to which it is approaching, and discloses those from which it is receding. These masses of matter, whatever they may be, are of enormous size; many of them, it has been calculated, stood out from the edge of the sun to distances of no less than 40,000 or 50,000 miles. Who shall say what these strange masses may be? Sir John Herschel says, "Flames they certainly are not; clouds of some sort it is extremely probable they are, of most excessively thin and filmy vapour, floating in a transparent atmosphere, which must for that purpose extend to a very considerable height above the luminous surface of the Sun."

In this rapid sketch an endeavour has been made to give a clear description of the different phenomena which have compelled the attention of our astronomers. We have learned that there is a vast solar atmosphere which extends far beyond the circumference of its denser mass, in which floats those illuminated vapours which are too attenuated to be seen except when the Sun's light is obscured. Below this is the photosphere—an ocean of light whose waves assume those willow-leaf forms which are remarkable in shape and size. Then, whenever by disturbances, which are clearly generated below this luminous sphere, the motion necessary to the formation of a dark spot is produced, we look into a region of penumbral clouds, and through these into a yet darker space. That the disturbances which have been observed to take place on the Sun's surface are evidences of physical energies promulgated on the most extensive scale, is proved by the fact that the formation of dark spots influences the magnetism of this earth. We know that an order of periodicity prevails in the intensity of the force of terrestrial magnetism, and we are convinced now that this is determined by the formation of solar spots. On one occasion two observers, far apart,* were observing a dark spot on the Sun, when there was a sudden outburst of light, which was due to the rushing of the willow-leaved forms, at the rate of 7,000 miles in a minute, to bridge over the vast opening in the photosphere. It is necessary to understand this, to state, that although at all ordinary times those willow-leaves lie at random, they arrange themselves symmetrically around a dark spot, and front inwards, like sedgy grasses streaming out into the waters of a pond. The sudden outburst of light which has been mentioned was due to the *floating* out of these forms, as in bridges, to cover in the opening (*see* Plate VI.) in this light developing ocean. When this occurred the Earth had her indications of it. Every magnetic bar in our observatories trembled, Aurora quivered in the skies, and our telegraphic wires were perplexed with the additional quantity of electricity which they had to carry.

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* See for most complete and accurate details, the Bakerian Lecture for 1862, on the Total Solar Eclipse of July 18, 1860, observed at Rivabellosa, near Miranda de Ebro in Spain. By Warren de la Rue, Ph.D., F.R.S. "Philosophical Transactions," Vol. 152, part 1.

Such are the manifestations of solar energy—how is this developed? and being constantly developed, how is it maintained? Spectrum analysis has taught us that the dark lines in the solar spectrum give us indications of the combustion of matter in the Sun. (*See* POPULAR SCIENCE REVIEW, Vol. I. p. 212.) The investigations of Kirchoff, Bunsen, Angström, and others, prove that the vapours of nickel, cobalt, iron, manganese, copper, zinc, barium, sodium, magnesium, chromium, calcium, aluminium, strontium, are present in the sun's gaseous envelope, and that hydrogen is also there. These metals must therefore be burning, in the mass of the Sun, to give that vapour which is detected in the Sun's atmosphere. If these results are received as truths, it may appear that the

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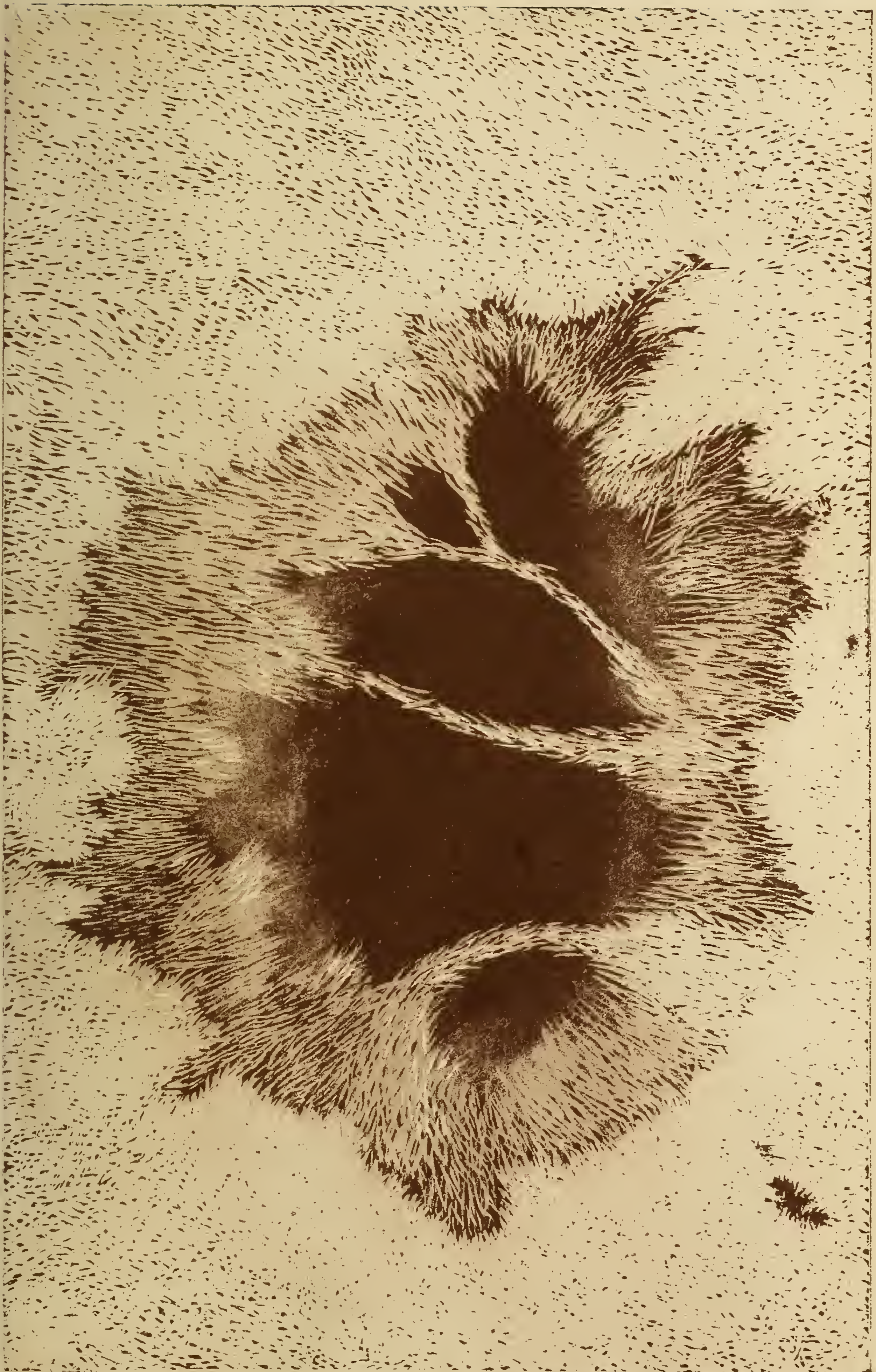
* Mr. Carrington and Mr. Hodgson.

darkness of a solar spot ought not to exist, but that we should look in upon a sphere intensely incandescent. In answer to this, it is replied: If the brilliant oxy-calcium light (the lime or Drummond light) be held between the eye and the sun, it appears as a black spot; consequently that the blackness of a spot affords no evidence that intense combustion may not be going forward. However this may be, it must be admitted that the weight of the results of observation and of experiment goes in favour of the hypothesis that the *Sun is a burning mass surrounded by vaporiform media,* circulating in all probability in well-defined zones, and exhibiting within themselves dissimilar evidences of vast energies. The inference is, that we derive light, heat, chemical power (*actinism*), and all the forms of electrical force from these zones of vapour. Now we know that physical energies can only be developed from matter by its undergoing a change of form. Man can only speak of the conditions with which he is acquainted. To produce heat or light from any body is to burn that body—that is, its form is changed. Ordinarily, oxygen is taken from the air, and the body undergoing combustion becomes an oxide. We can only understand the combustion of iron—leading to the production of iron vapour—in the sun, by supposing some such change as this. No matter is *destroyed,* either on this Earth or in the Sun, by the processes of combustion. The oxidized or changed particles return back again into the orb from which they originated. The solid matter of the Sun cannot pass beyond the influence of its own gravitating force; therefore there cannot be any waste of it. But in the process which develops those vast energies—the physical forces—they are radiated off into space, and a constant waste of them must be going on. Unless there were some provisions for restoring to the Sun its energy, it would in time become a dead globe of metallic ashes, and every planet would pass into the same state. How then are the physical forces restored to the central orb from which we derive them? What provision is there for the permanent maintenance of those energies upon which heat and consequently life and light depend? The answers to these questions are amongst the finest speculations of our modern philosophy. For the answers which have been given we are chiefly indebted to the inquiries and speculations of Herschel, Joule, Waterston, Thomson, and Mayer. It is difficult to give a brief explanation of so large a subject, but since the hypothesis which is comprehended within what is termed *"the conservation of energy"* has its foundation in the well-known law of gravitation, it may not be necessary to enter into a tedious discussion to render it clear to the general reader. It has been already said that a mass of matter falling to the Earth acquires a certain



Tuffen West lith.

W West imp.

SOLAR SPOT.

Showing the Phenomena of "Willow Leaves"

BRITISH MUSEUM
NATURAL HISTORY.

velocity in its fall, and that if at any point its motion be interrupted, that motion will be converted into heat. The blacksmith's hammer falls upon a bar of iron, and both are heated by the blow; he lifts the hammer and it falls again, when double the heat is the result; he gives a rapid succession of such blows, and exactly in accordance with their force is the intensity of heat developed, until the iron glows with red—this is *visible* heat.

Sir Isaac Newton saw the necessity of restoring to the Sun the heat and light emitted, and he supposed that comets might be the agents employed to gather up force in space, and by constantly falling into the Sun, restore that force to it. For cometary masses, the modern philosophers—following Mr. Waterston—have substituted meteorites, which are supposed to fall—as it were to rain—down upon the Sun. Every one of these reaches the Sun with a store of force, represented by its motion, and that motion being stopped, heat is the result. It has been supposed that the nebulous light of vast dimensions which surrounds the Sun, and to which we have given the name of the zodiacal light, may indicate the crowd of massive asteroids—the rain of fire-balls which is for ever restoring the wasting energy of the solar centre. Mayer finds—

> that a mass which after moving in central motion arrives at the Sun's surface has the same velocity as it would possess had it fallen perpendicularly into the Sun, from a distance from the centre of the Sun equal to the major axis of its orbit; whence it is apparent that a meteorite, arriving at the Sun, moves at least as quickly as a weight which falls freely towards the Sun from a distance as great as the solar radius or 441,600 miles. . . . The velocity therefore of an asteroid, when it strikes the Sun, measures from 445,750 to 630,400 metres in a second; the calorific effects of re-percussion are consequently equal to from 27½ to 55 millions of degrees of heat (Centigrade) . . . An asteroid, therefore, by *its fall into the Sun develops from* 4,600 *times to* 9,200 *times as much heat as would be generated by the combustion of an equal mass of coal.*

Calculations have been made to show the value of known masses of matter as restorers of solar energy. It has been demonstrated that if our Moon fell into the Sun it would cover the Sun's expenditure of force for more than one and less than two years, and the mass of the Earth would support the solar energy—that is, it would by its fall into and incorporation with the Sun, generate heat sufficient to last the Sun from 60 to 120 years.

The meteorites—asteroids—of our system are countless, and quite sufficient to meet all the exigencies of the case. It may be argued that man has no evidence of any increase in the mass of the Sun which it may appear should arise from this meteoric rain. To this it is replied that assuming the specific gravity of the meteorites to be the same as that of the Sun, it would require from 36,000 to 60,000 years to enlarge the sun's apparent diameter to the extent of one second.

Professor Thomson adopted the theory of Mr. Waterston, and he has much extended it. In evidence of there being observed motions capable of producing those great effects, he says, referring to the observations of Mr. Carrington and Mr. Hodgson:—

> It appears indeed from recorded observations quite certain that two bodies elongated in the direction of their motion, moved rapidly along above the actual surface of the Sun, suddenly bursting into view by means of their emitted light, and then dying gradually out after having described an arc nearly parallel with the ecliptic, and at the rate of about 7,000 miles in a minute. Now here we have a velocity such as nothing we know of short of orbitual motion in the neighbourhood of the Sun can give. But as in the immediate neighbourhood of the Sun, or close to his surface, where we may presume the observed bodies to have been, the true orbitual velocity is about 16,000 miles in a minute, we have a destruction from some mechanical resistance of 9,000 miles of motion in a minute; which, multiplied with the mass of the bodies so retarded, would at once indicate the heat they ought to have given out,—something so great, doubtless, as to be necessarily accompanied by the intense light which was testified to by the above observers.

This, at present the accepted theory, regards all the physical forces as modes of motion. The heat, which flows from the Sun, and the associated powers, light, electricity, and actinism, are, according to this view, only manifestations of power, resulting from interrupted, or changed, motion. These energies, as pulsations, flow through the ninety millions of miles of space between us and the Sun, and are expended when they reach this Earth in changing the form of matter. Not only are vital organisms the result, but every inorganic mass is disturbed by these influences, and the geometric arrangements of matter into crystalline forms are, beyond all doubt, as much influenced by the solar pulsations as is the formation of a leaf or the creation of an animal cell. Many would refer the phenomena of life to the combined action of these solar energies.

But regarding Life—vital force—as a power far more exalted than either light, heat, or electricity, and, indeed, capable of exerting a controlling power over them all, we are certainly disposed to view with satisfaction that speculation which supposes the photosphere to be the primary seat of vital power, and to regard with a poetic pleasure that hypothesis which refers the solar energies to LIFE!

SOUP FOR CHILDREN.

BY BARON LIEBIG.

FOR mothers who are denied the happiness of suckling their own children, or who have not sufficient nourishment for them, the choice of fitting food is a matter of importance. Custom and opinions formed at hap-hazard decide generally the question; and as the simple laws of nutrition which ought to determine it are mostly unknown to the parties concerned, the bodily development of the child in its earliest youth often suffers considerably by the sort of food employed. It must be intelligible to any one, that a child deprived of its mother's milk and having no wet-nurse (the choice of one being difficult and often attended with danger), can only be fed properly, when the food given is equivalent in nourishing power to that of woman's milk.

In order to form a correct notion on this point, it will perhaps be as well to remind my readers that milk contains two different matters, each essential for the performance of various functions in the human body.

From the casein in the milk is formed the principal ingredient in blood, and from this the chief elements of flesh: the butter and sugar of milk are requisite for various other purposes, and serve finally to produce animal heat. The food of man and the fodder of animals resemble milk inasmuch as they invariably consist of a mixture of two analogous classes of matter, one of which plays the same part as the casein, the other as the fat and sugar of milk; so that from the food taken blood and flesh are produced, and the temperature of the body maintained.

The seeds of our cereals contain a matter identical with curdled cheese; the seeds of pease and beans a matter like the cheese, which, as we have seen, milk also contains in a soluble state.

In corn-flour there is, it is true, no sugar of milk, and but little fat; but it is rich in starch, which in the stomach is converted into sugar.

For the normal support of life, the proportion of blood and heat-producing elements in food is not unimportant. In order for his body to increase in weight or to grow, an individual requires not only food in an increasing ratio, but also blood and heat-producing elements in different proportions, according to his age and weight.

To *Haubner* is to be attributed the great merit of having in a practical manner caused farmers to understand the necessity of a just proportion of these two classes of substances in the nutrition of animals; a circumstance to which I had called attention in my "Familiar Letters on Chemistry." By the admirable investigation of *Henneberg, Stohmann, Knop, Arendt, Baehr, Pincus,* and others who followed in his steps, the foundation of a scientific doctrine of nutrition has been laid. The farmer is enabled by it to supply the failing milk or hay—the universal food for young and grown animals—by the correct mixture of other provender which his field produces, oat or rye straw with turnips, roots, potatoes, rapemeal, pease, and beans, as the case may be. By following strictly the law of nutrition, many farmers have succeeded in producing milk and flesh much cheaper than before, often indeed at half the cost.

The above-mentioned researches have proved that when the two elements of food have been given in proper relative proportions, befitting the wants of the individual, the result of the two is a maximum of the nutritious effect belonging to each.

A smaller proportion of heat-producing matter than is wanted may be replaced in the food by a certain amount of blood-forming elements, but that excess over the required quantity loses its nutritive value: that is, its power to increase the weight of the body, or of forming flesh. The heat-forming substances are incapable of forming blood or flesh; an excess of them in the food therefore produces no effect. It is presupposed that the individual receives as much food as the inclination or appetite demands.

If we admit that a boy, merely to keep up his weight, requires daily half-an-ounce of blood and flesh-producing matter, we shall see that he would receive this from a potato diet, if he were able to consume daily 1½ lb. (24 ounces) of steamed potatoes. For the increase of the muscular substance in his body, he would have to take a still larger quantity.

Potatoes contain, for every one part of blood-forming matter, from 9 to 10—let us say 10 parts of heat-producing substance (starch). In 24 ounces of steamed potatoes are 5 ounces of starch, of which only 2½ are employed in the body for the production of heat. The remaining 2½ ounces burthen the intestines, and pass away without doing any good.

In 5 ounces of pease is 1 ounce of blood-forming substance (as much as in 48 ounces of steamed potatoes), besides 2½ ounces of starch. It is clear, if we mix 12 ounces of steamed potatoes and $2\frac{1}{2}$ ounces of pap made of pease, we have :—

	Blood-forming,		Heat-producing substance.
12 ounces Potatoes contain ...	0·250 ($\frac{1}{4}$)	...	2·50 ($2\frac{1}{2}$)
$2\frac{1}{2}$ „ Pease „ ...	0·500 ($\frac{1}{2}$)	...	1·25 ($1\frac{1}{4}$)
$14\frac{1}{2}$ ounces, containing	0·750 ($\frac{3}{4}$)	...	3·75 ($3\frac{3}{4}$)

or the proportion 1 : 5, answering to the requirement of the boy. He will not only digest this mixture of $14\frac{1}{2}$ ounces of potatoes and pease more easily than the larger bulk of 24 ounces of potatoes which nourished him imperfectly, but he will in this smaller weight of food receive one quarter more blood-forming nourishment ; a surplus necessary for the boy's growth, that is to say requisite to increase the weight of his body.

This may serve to exemplify the principles which have directed me in preparing a food for infants. Their correctness has been fully confirmed by the experience of many farmers, in their aim to produce milk and flesh.

The composition of milk is not constant: its constituent parts (casein, butter, and sugar of milk) vary in their relative proportions, according to the food with which the individual has been nourished.

According to the analysis of *Haidlen*, the milk of a healthy woman contains in one hundred parts 3·1 casein, 4·3 sugar of milk, and 3·4 parts of butter ; it is generally poorer in casein than cow milk. If we admit that 10 parts of butter perform the same function in the animal body as 24 parts of starch (see Letters on Chemistry, p. 402) and 18 parts of sugar of milk as that of 16 starch, we may be able to compare, with some exactness, the nutritive value of milk with that of vegetable food (flour of wheat, &c.) by expressing the weight of butter and milk-sugar in milk by its equivalents in starch.

We find, accordingly, that,—

		Proportion of blood-forming,		Heat-producing matter.
Woman's milk	contains	1	...	3·8 to 4·0
Cow's milk, fresh	„	1	...	3·0
Skimmed cow's milk	„	1	...	2·5
Wheat flour	„	1	...	5·0

Woman's milk contains less salts than cow's milk, but it possesses a stronger alkaline reaction, and contains more free alkali, which in milk is always potash.

It is clear that we can easily calculate what mixture of cow's milk and flour will contain the same proportion of blood and heat-producing ingredients as woman's milk (that is to say, the proportion 1 : 3·8), but in other respects it would still not replace woman's milk, because wheaten flour has an acid reaction, and contains less alkali than milk. This alkali we must presuppose is requisite in the body for the normal functions of the child. And even although starch be not unfitting for the nourishment of the infant, the change of it into sugar in the stomach during digestion imposes an unnecessary labour on the organisation, which will be spared it if the starch be beforehand transformed into the soluble forms of sugar and dextrine.

This is easily done by adding to the wheaten flour a certain quantity of malt.

If a sort of pap be made by boiling milk and wheaten flour, and adding to this a given quantity of malt flour, the mixture will soon become fluid and acquire a sweet taste. It is on this transformation of starch into sugar, and by supplying the failing alkali in the milk, that the preparation of this new soup is based.

The skimmed milk that is sold contains in itself seldom more than 11 per cent. of solid matter (4 casein, 4·5 sugar of milk, and 2·5 butter), in which blood-forming and heat-producing ingredients are present in the proportion of 1 : 2·5; hence by adding 1 part of wheaten flour and 1 part of malt flour to 10 parts of skimmed cow's milk, a mixture is obtained which agrees with the composition of woman's milk.

	Proportion of blood-forming,		Heat-producing matter.
In 10 parts of cow's milk are contained ...	0·40	...	1·00 part.
„ 1 „ wheaten flour	0·14	...	0·74 „
„ 1 „ malt flour	0·07	...	0·58 „
	0·61		2·32

These numbers correspond to the proportion of 1 part of blood-forming to 3·8 parts of heat-producing matter. The analysis of malt shows that it contains 11·12 per cent. of blood-forming matter, but in the soup itself only 7 per cent. is retained. As wheaten flour and malt flour contain less alkali than woman's milk, this must be supplied when preparing the soup. I have found that the addition of 3 grammes (45 grains, 30 drops, 2·8 cubic centimeter) of a solution of carbonate of potash containing 11 per cent. of this salt, or instead of this 7¼ gr. of bicarbonate of potash, is sufficient to neutralise the acid reaction of the two sorts of flour. A few drops more render the mixture slightly alkaline.

The soup is to be prepared as follows :—

One part of wheat-flour (½ an ounce) is put into the vessel used for making the soup, and 10 parts (5 ounces) of skimmed cow's milk are then added gradually in small quantities, the mixture being stirred all the time uninterruptedly, to prevent the pap forming into lumps. To this mixture the above-mentioned quantity of alkali is added and then made to boil, the stirring continuing all the while, and after boiling for 3 to 4 minutes, the vessel is removed from the fire.

One part ($\frac{1}{2}$ an ounce) of malt flour is now weighed, and mixed with 2 parts of water, and this is poured into the hot pap, and the whole once more stirred the while.

The vessel is then covered to prevent the contents from cooling, and left to stand for half an hour. In order to avoid a too rapid cooling of the soup, it is advisable after the addition of the malt, to put the vessel in hot—nearly boiling—water, by which it becomes thinner and sweeter. At the end of this time the whole is passed through a fine sieve, in which the bran of the malt flour remains behind.

For those persons who are acquainted with the mashing process, it is hardly necessary to call attention to the circumstance that after the addition of the malt the temperature ought not to exceed 148° F. (65° C.).

In the preceding directions the time reckoned for the weighing and mixing the malt flour with water is exactly sufficient to cool down the boiling milk pap to such a degree that, when the malt is added, this mashing temperature is obtained.

A shorter mode of preparing the soup, but requiring a little more attention, is the following:—Half an ounce of wheaten flour, and an equal quantity of malt flour, 7¼ grains of bicarbonate of potash, and 1 ounce of water, are to be well mixed; 5 ounces of cow's milk are then added, and the whole put on a gentle fire; when the mixture begins to thicken it is removed from the fire, stirred during 5 minutes, heated and stirred again till it becomes quite fluid, and finally made to boil. After the separation of the bran by a sieve, it is ready for use. By boiling it for a few minutes it loses all taste of the flour.

Wheaten Flour.—The flour to be taken is not the finest sort, or what is called "firsts," which contains more starch than the other sort, but common fresh flour, or "seconds."

Malt Flour.—Barley malt may be had from every brewery. In Germany, or rather in Munich, the malt is dried in a higher temperature than in England; the starch of the corn is half-roasted. When this malt is used for such soup, it gives it a bread flavour (of brown bread), which is not disagreeable. English malt yields a whiter flour; the most excellent that has passed through my hands was that from Bass's brewery in Burton-on-Trent. Malt also contains many seeds of illweed, which first must be picked out. A common coffee-mill is used to grind the malt; the coarse powder is to be passed through a sieve to separate the husks.

Carbonate of Potash.—The usual bicarbonate of potash and salt of tartar of the apothecaries is sufficiently pure. To obtain the above-mentioned solution, two ounces of carbonate of potash are dissolved in one pound (16 ounces) of water. If well-water be taken, a deposit of carbonate of lime is usually formed; but in an hour the liquid will grow perfectly clear. If common pearlash be used, two ounces and a half are taken for one pound of water, and the liquid must be allowed to stand till it is quite bright.

Remark.—In order to obviate the troublesome process of weighing the flour, &c., it may be remarked that a tablespoonful (heaped up) of wheaten flour weighs pretty nearly half an ounce, a heaped dessert-spoonful of malt flour weighs also half an ounce. For measuring the solution of carbonate of potash, a common thimble may be used, which, if filled with it, will contain about 3 grammes, or 45 grains. For the milk and the water, one may get an apothecary to weigh two and then five ounces of water, and pouring each into a common tumbler, the several quantities can be marked by gumming two strips of paper on the outside of the glass.

When the soup is properly prepared, it is as sweet as milk, and any further sweetening is unnecessary. It contains the *double concentration of woman's milk.* After boiling, the soup will keep 24 hours without undergoing any change.

The immediate inducement to my making such soup was the circumstance that one of my grandchildren could not be suckled by its mother, and that another required, besides his mother's milk, a more concentrated food. In both cases, as well as in other families where it had been introduced, the soup proved an excellent food; the children thrived perfectly well, and many a petty suffering disappeared after some weeks' use of the soup. I often take it (prepared with 10 parts of milk and two parts of malt flour) with tea for my breakfast. It has a slight flavour of malt, to which children soon get accustomed; after some time they like it better than any other food. A Munich physician, Dr. Vogel, who has a very extensive practice among children, endeavoured to introduce this soup in the families of the poor, but without success, because the thick pap, as soon as the malt flour was added, became suddenly converted into a thin fluid. The nurses objected to it, for they thought that the nutritious powers of the preparation were connected with the thickness of the pap, and that these, by the admixture of the malt, suffered a diminution.*

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* For the use of more wealthy families, Doctor Von Pfeufer, the most renowned physician in Munich, has induced the apothecaries of the town to keep for sale a mixture of half an ounce of malt flour and 7¼ grains of bicarbonate of potash, milk and wheat flour being supposed to be in every house. The malt flour ought to be always freshly made from the malt.

VEGETABLES, FRUIT, AND WATER AS SOURCES OF INTESTINAL WORMS.

By T. SPENCER COBBOLD, M.D., F.R.S., F.L.S.,

LECTURER ON COMPARATIVE ANATOMY AT THE MIDDLESEX HOSPITAL.

RESPECTING animal food as a source of parasites, it is not difficult for the helminthologist to explain how certain well-known species of entozoa are introduced within the human body; but in the case of vegetables he cannot speak with equal preciseness, seeing that the subject is surrounded with many and great difficulties. As a general proposition, however, it may be truthfully averred that entozoa are frequently introduced into our stomachs along with vegetable food; but we are not thereby warranted in the conclusion that the parasites existed within the parenchyma or tissues of the vegetable substances thus swallowed. Neither, on the other hand, are we yet in a position to state with certainty that the vegetable matters in question did *not* actually harbour the parasites within their tissues. In various plants I have, from time to time, noticed free nematodes within their parenchyma; and in certain instances I have entertained the belief that they were in the sexually immature condition. Whether any of them were the larvæ of, and therefore specifically identical with, certain well-known forms of human entozoa, can only be a matter of conjecture; nevertheless, to indicate to what extent particular human parasites are clearly referable to the various sources under consideration, I invite attention to the following facts:—

WATERCRESSES, &c.—Under this head may be included various pondweeds, and different kinds of vegetable *débris*, floating in ditches, lakes, and semi-stagnant waters; for, even in cresses prepared for the table I have noticed portions of frog's-bit (*Hydrocharis morsus ranæ*) and other weeds. These vegetables have often small mollusks and other aquatic animalcules adhering to them, and if the former are eaten in an imperfectly washed state, it will consequently happen that the latter are swallowed during the meal. Small mollusks are known to harbour larval parasites, more or less like the one here represented (fig. 1), in prodigious quantities, and therefore it is not unreasonable to conclude—bearing in mind the extent of our knowledge of the transformations which these parasites undergo—that they are at least the source of one or more of the fluke parasites which occasionally invade our frames. The following case will best illustrate my subject:—A young girl, the daughter of a shepherd living at Kaplitz, in Bohemia, was in the habit of eating watercresses, and drinking the stagnant water of ditches in the locality where she lived. After a while her health failed and her body became much enlarged. A medical man, Dr. Kichner, saw her only three days before she died, and by a *post-mortem* examination, he ascertained that no less than forty-seven specimens of a small fluke (*Distoma lanceolatum*, fig. 2), had taken up their residence in this inappropriate "*host*." I say "inappropriate" because the parasite species in question has only three times been detected within the human "host;" its proper habitation being, apparently, the liver of the ox and sheep. In addition to its accidental introduction into the human host, the *Distoma lanceolatum* strays occasionally into the bodies of pigs, deer, hares, and rabbits. The lowermost larval condition of this parasite is known to be a minute ciliated creature which swims about freely in the water; but its higher larval form (*Cercaria*), though certainly occupying the body of some mollusk, has not been clearly and precisely indicated.

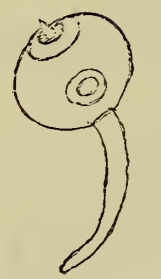

Fig. 1.—Tailed larval trematode, or young fluke (*Cercaria pugnax*); from the body of *Paludina vivipara*; × 180 diam.

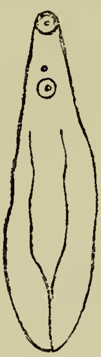

Fig. 2.—*Distoma lanceolatum*; × 3 diam.

The same kind of demonstration is yet wanting to clear up the only remaining link which is wanting to complete the chain of evidence as regards the introduction of the common fluke (*Fasciola hepatica*, fig. 3) into the human body, and into the liver of the sheep, giving rise in the latter to the formidable rot disease. Not a vestige of doubt exists that we and they—*i.e.* ourselves and the sheep—alike obtain this parasite by swallowing the larvæ of this entozoon along with vegetable matters. It may be, indeed, that the intermediate bearers are swallowed along with the water drunk, but it is much more probable that the mollusks are usually adherent to watercresses, grass, or other vegetable food. The details connected with their migrations, development, and transformations, I have partly worked out and explained elsewhere, so that I am only now more immediately concerned to show that in the preparation of vegetable as of animal food, it is of

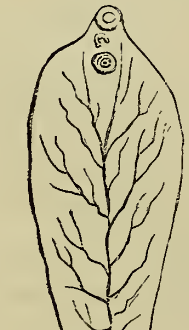

Fig. 3.—Common fluke (*Fasciola hepatica*); natural size.

essential importance to adopt the cleanliest habits, and to avoid swallowing small snails and other minute animals, which, despite all our precautions, will occasionally have escaped notice.

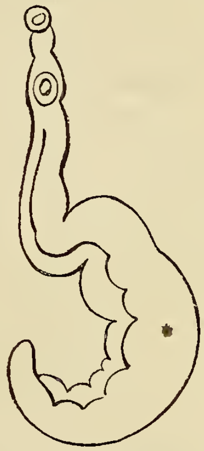
FIG. 4.—*Bilharzia hæmatobia;* × 10 diam.

Three other human fluke parasites exist, the larvæ of which are, in all likelihood, obtained from sources similar to those above mentioned; but as these parasites have not, at present, been found to affect the inhabitants of these islands, I forbear to point out the formidable symptoms which one of these entozoa is known to occasion in our species dwelling in Africa. I must confess, however, that I think it not improbable that, ere long, some of our home-bound colonists will be the means of introducing this parasite (*Bilharzia hæmatobia*, fig. 4) and its terrible helminthiasis into this country; and if it once gets among us, it will, I fear, also be exceedingly difficult of extermination. That it would flourish here there can be little doubt, seeing that eggs and living specimens have already been found in this country, imported both by human and monkey "hosts."

FIG. 5.—*Oxyuris vermicularis;* × 5 diam.

FRUIT.—A very prevalent notion exists throughout all classes of the community, that the eating of fruit, especially if it be unripe, gives rise to one of the most common parasitic maladies with which we are acquainted. I allude of course to the symptoms occasioned by the little thread-worm (*Oxyuris vermicularis*, fig. 5). With the view of bringing this popular idea to the test of experiment, I tried to rear embryonic Oxyurides in apples and pears. At first I thought I had succeeded, but a subsequent repetition of the original experiment, combined with a re-investigation of the entire circumstances of the case, have only served to persuade me that we have no evidence whatever to show that any of our nematode invaders are derivable from fruit. In other words, it is not at all likely that fruit is ever an intermediate bearer of any of the parasites which ordinarily occupy the human body. Certainly a great many evils affecting children are laid to the charge of ripe and unripe fruit, but, in so far as entozoa are concerned, these surmises are probably groundless. It is, doubtless, within the bounds of possibility that one or other of the two species of human Ascaris, properly so called, may be introduced along with fruit into our stomachs; but here, again, one naturally asks whether the larvæ may not have been adherent to the surface of the fruit so introduced? From what follows in the sequel I think this will be shown to be the probable source of the entozoa in question; and, as regards the *Oxyuris vermicularis* we are still entirely in the dark respecting its development and migrations. Some go so far as to state that the Oxyuris requires no intermediate bearer; but this is a view which I believe to be contra-indicated by all that we know respecting the development and migrations of its nearest allies.

Celery, Cabbages, &c.—Under this head we may include all the ordinary market-garden vegetables commonly in use; for the remarks which apply to one kind of garden vegetable necessarily, as far as entozoa are concerned, apply to every other kind derived from the same source. . Decomposing animal and vegetable matters appear to be eminently favourable to the development of the embryos of certain nematode worms; and hence it happens, that the more filthy the water, sewage, or liquid manure employed to increase the fertility of garden crops, the more likely are the latter to supply us with the larval forms destined, in the absence of the requisite precautions on our part, to gain access to our stomachs. Thus, in the instance of a mere infant of 13 months old, whose case I have already placed on record, and who suffered from the round-worm (*Ascaris mystax*, fig. 6), which commonly infests the cat, I was informed by Mr. Scattergood, the medical attendant, that for two or three months previous to the child's illness, the nurse had frequently given it a piece of celery to chew. The evidence, moreover, that the entozoa had been derived from this source was tolerably conclusive, not merely from the negative circumstance that the child had never partaken of raw meat and uncooked hams, but also from the fact that it seldom drank any water; and even in those few instances in which it had done so, the water had always been carefully filtered, and was the same as that commonly drunk by the family. As Mr. Scattergood observed, the market gardens about large towns are often watered from ponds containing all sorts of abominations, and consequently one cannot too strongly recommend the thorough washing of all vegetables supplied from this source. In connection with this subject, it is not a little instructive to remark that in the celebrated case of Mary Riordan (where 1,206 coleopterous larvæ of *Blaps mortisaga*, some perfect insects, several specimens of *Ascaris mystax*, and one example of *A. lumbricoides* were entertained by the "host"), the patient had, from superstitious motives, long practised the repulsive habit of drinking water mixed with clay taken from the grave of a priest. If,

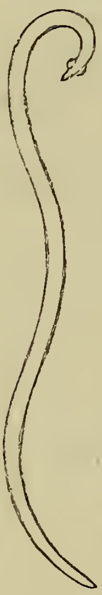

Fig. 6.—*Ascaris mystax;* natural size.

as seems probable, there were no vegetable matters consumed in this instance, it tends to strengthen one's conviction that it is not the vegetables themselves which ordinarily supply us with the nematode larvæ, but rather the putrid water or soil which is brought into contact with this kind of food.

Even should these vegetables fail, of themselves, to harbour parasite larvæ destined to complete their life-period within the human host, it by no means follows that they do not act as intermediary bearers of entozoa, known to infest the higher animals in their adult state. Were I tempted to pursue this subject further, I might adduce someinteresting data respecting the prevalence of nematodes, not only in the highest classes of plants, but also within the tissues of certain fungi; and these parasites, so far as my observations extend, are apparently destined to take up their ultimate abode within the alimentary passages of birds and mammals. The gape disease of game and poultry is doubtless propagated in some such way as this; but, as I have fully opened up this subject elsewhere (see the Journal of the Proceedings of the Linnean Society), I forbear to enter into further details on this head. In course of time I hope to witness a wider appreciation of the importance of this subject, but meanwhile I acquiesce in a distinguished individual's advice, and am content to "rest and be thankful."

WATER.—I have already incidentally alluded to the undoubted fact of the existence of larval parasites in impure water, properly so called; but it remains for me to throw more light on this subject; and also to show that parasitic larvæ may abound in water which would not ordinarily be regarded as otherwise than pure. A glass of *apparently* clean spring water *might* contain numerous eggs and embryos of entozoa, without their presence being visible to the naked eye; yet, as a general rule, it may be confidently affirmed that in so far as entozoa are concerned, fresh spring water is quite innocuous. Water, as commonly supplied from artificial reservoirs in this country for household purposes, is almost absolutely harmless; but the same cannot be said of that which is stored up in the large tanks of tropical countries. It is almost absolutely certain that the larvæ of the Dracunculus, or Guinea-worm (fig. 7), are abundant both in artificial tanks and in open waters; but as this parasite is not introduced into the human body from water employed as *drink*, a consideration of its mode of introduction would be out of place on the present occasion. I am more immediately concerned to show that the people of these islands suffer from entozoa which must be introduced in our systems along with drink of some kind or other.

The presence or absence of the eggs and larvæ of human entozoa in water used as drink is entirely dependent upon the locality whence the water is procured; and the particular parasites met with will also be dependent upon various contingent circumstances requiring explanation. Common pond, lake, or ditch-water will, as I have already hinted, be liable to harbour the larvæ of trematodes, which, fortunately, do not much trouble our countrymen, except, in so far as they annually destroy an immense number of domestic animals whence we obtain our largest suply of food. Stagnant waters, however, are liable to contain the eggs and embryos of at least three species of tapeworm known to be highly injurious to the human body (fig. 8). We may not only act the part of "host" to the fully-developed *Tænia solium* derived from the pork-measle, but may also entertain the measle (*Cysticercus cellulosæ*) itself. In our bodies, moreover, this larval cestode seems particularly anxious to ensconce itself within our brains, and, consequently, not a few deaths annually occur from this cause. The Registrar-General includes such cases in his sum total of cerebral diseases; but, for all that, the brain may have been perfectly healthy, except in so far as its integrity has been cancelled by the inconvenient pressure exerted by a growing parasite seldom larger than a common bean. Epilepsy and epileptiform seizures are occasionally traceable to this cause; but to what extent this particular form of brain measle malady may exist amongst us we have, at present, no accurate means of deciding. Every now and then, however, such cases turn up, both in England and abroad, and Dr. Griesinger alone has collected records of more than fifty cases. But I forbear to dwell further on this aspect of the question, preferring to note, in passing, how these larvæ arrive within the brain territory. Clearly they have bored their way into the circulating medium, by penetrating the coats of the stomach, and on being transported by the blood-current to the head, have voluntarily lodged there. They were introduced into the stomach along with water; and they originally gained access to the water by escape from the parent tapeworm, possibly whilst the latter was still lodged within the alimentary passages of the primary human host. Sometimes the *Cysticerci* penetrate the body in a more direct manner; but these are cases with which we are not now concerned.

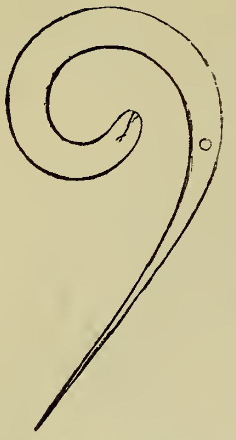

FIG. 7.—Young of the guinea-worm (*Dracunculus medinensis*); × 300 diam.

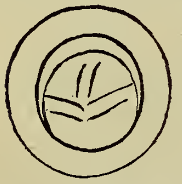

FIG. 8.—Egg of the tapeworm (*Tænia solium*); × 400 diam.

Pond, ditch, lake, and even river water, may also contain the eggs and six-hooked embryos of the hookless tapeworm (*Tænia mediocanellata*); but whether or no these larvæ are capable of attaining the higher larval grade, or cysticerca stage of development, within the human body, is a point which, so far as my experience goes, remains yet to be ascertained. I certainly see no reason for supposing that we escape its invasion; on the contrary, I am pretty confident that it has been hitherto overlooked, merely because observers generally are, as yet, entirely unfamiliar with its characteristic features.

Whatever difficulties, however, exist in regard to detection of the larvæ of the two kinds of *Tæniæ* just referred to, none need occur in the case of a third species. I allude to the familiarly known hydatid (fig. 9). These bodies are the young of the *Tænia echinococcus*, and we are exposed to their terrible ravages by drinking water containing the eggs of this tapeworm. The eggs at the time of their being swallowed must be mature, or, in other words, must already contain six-hooked embryos, if we are to become their parasite bearers. The tapeworm itself is extremely minute, and resides in the alimentary canal of the dog. If neither dog nor wolf existed, we should probably be free from the invasions of this parasite. The eggs escape their canine host, and, by various possible and easily explained ways, are transported into ditches, ponds, cesspools, lakes, and streams. They are so minute, that hundreds might exist in a glass of water without their being recognized by the naked eye; yet any one of them gaining access to our stomach would be sufficient to endanger life. The larvæ, though generally preferring to make their way to the liver, are not at all particular, and, consequently, will often select the other internal viscera, the brain, or even the interior of the bones. I know of eight instances where they took up their residence in the tibia. It is of little moment, however, to say more on this head, save for the purpose of showing the frequency of the hydatid disease amongst us. Here, again, we have no accurate data to rely on; yet, so far as my observations have extended, I can positively assert that many lives are annually sacrificed from this cause. I say "sacrificed," because the disease is preventible. No one need drink water impregnated with the ova of entozoa, even though the water may look pure. Artificial reservoirs to which dogs have no access cannot contain the eggs of *Tænia echinococcus*; neither, in like manner, are we likely to obtain them in well or spring water. But open waters, into which the carcasses of dogs are occasionally thrown, or into which tapeworm-eggs may have been carried by rain and other agencies, are always liable to contain them. The eggs may also be introduced with food which has been immersed in or washed with water from this source. It comes

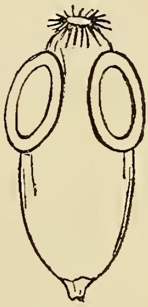

FIG. 9.—One of the so-called Echinococcus—heads or scolices from the interior of an hydatid cyst × 150 diam.

to the same thing in the end. Even doubtfully pure water may be drunk with impunity if previously boiled, or distilled, or carefully filtered. The filter, however, should not permit organic particles much larger than the $\frac{1}{1000}$ of an inch in diameter to pass through it, if we would be perfectly certain as to the absence of the eggs of the *Tœnia echinococcus.*

It is a matter of no small moment to notice that, as in the case of *Tœnia solium,* one human individual acting the part of "host" in any given neighbourhood, may endanger the lives of several of his fellow-creatures; so also may one canine "host," or bearer of the *Tœnia echinococcus,* serve us a similar turn. It was partly from my knowledge of this circumstance that I was induced to suggest a preventive rule at the Cambridge meeting of the British Association in 1862, which rule I may here be permitted to repeat. It is this: "All entozoa not preserved for scientific investigation or experiment should be destroyed by fire, and under no circumstances whatever should they be thrown aside as harmless refuse." This proposition is not merely given as a hint to commencing investigators and pathologists; but, rather, to unscientific meat-inspectors, butchers, fleshers, knackers, and their associates, who, from benevolent motives, are in the habit of flinging "doubtful portions" to dogs which frequent their neighbourhood. In this way the tapeworms are frequently reared, and our lives are consequently placed in jeopardy. Echinococcus-cysts are well known to butchers, and I have even see these and other entozoa brought to table.

Beer, Porter, &c.—All I need say in regard to these fermented drinks is that, entozoologically speaking, they are perfectly harmless. Even though impure waters were employed, the boiling of the worts would alone be sufficient to destroy any number of parasite eggs which might previously exist. In non-fermented drinks, however, such as ginger-beer, lemonade, soda-water, and the like, we cannot be absolutely certain of avoiding parasite eggs and larvæ. It all depends upon the source whence the manufacturer procures his supply of water. In most cases it is obvious he will have obtained the cleanliest within his reach; and therefore we may conclude that, generally speaking, there is little or no danger to be apprehended on this score. In regard to wines, the same remarks are, to a certain extent, applicable. Any considerable amount of alcohol added to water is certainly sufficient to destroy the vitality of parasite eggs or their larvæ; but I very much doubt if the amount of spirit ordinarily developed in our home-made English wines is sufficient to effect this purpose. Manifestly, it is advisable that only the purest water should be employed in the preparation of all these drinks; for then only can we be said to be absolutely certain of avoiding parasite infection.

THE ANATOMY AND PHYSIOLOGY OF THE FORAMINIFERA.

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THOUGH no miscroscopic creatures have been so frequently described by naturalists as the Foraminifera, there are few respecting which our information was, until recently, so erroneous; but this state of things is rapidly passing away, not only in the case of the objects spoken of, but of a number of other creatures, whose zoological position was equally dubious. The modern group of Rhizopods has been constructed out of a number of zoological foundlings that, like "Japhet in search of a father," have long vainly hunted for their next of kin. Within the last few years Sponges have been proved to be animals, and may now be regarded as the federal head of their race. The Polycystineæ, those exquisite specimens of silicious filigree-work, have been found to be first cousins to the Sponges. The active Polygastrica, so singularly misnamed, since, instead of having more stomachs than their neighbours, they have no stomachs at all, are the light brigade of the same slow-moving race; whilst the Foraminifera, long regarded as the poor relations of the aristocratic Nautili, now occupy a dignified position in the family group; whilst, if the Proteus animalcule cannot boast of a skeleton that is valuable for its usefulness, like that of the Sponge, or classic in its beauty like those of the Polycystins or of the Foraminifera, it has the comfort of knowing that through the very simplicity of its unadorned body it has contributed more than all the rest to a right understanding of the now happy family.

We have learnt that the characteristic feature of the group lies in the translucent jelly-like substance forming the living animal, and to which the name of "sarcode" is now commonly given. This sarcode presents its simplest form in the Amœba or Proteus animalcule, so common in stagnant rain-water. From this type, in which few or no traces of organization can be seen, we pass to the higher forms of the Polygastrica, where important organs appear to exist, endowed with special functions.

The subjects of this paper appear to be neither the highest nor the lowest forms of this Rhizopodous group. The earlier observers were misled by the chambered calcareous shells, which looked so like those of Nautili that all naturalists from Soldani to D'Orbigny fell into one common error and called them Cephalopods. To M. Dujardin belongs the merit of having put them in their right place, leaving no ground for doubt or question respecting their relationship to the Amœbæ. Starting from this acknowledgment of their rhizopodous nature, we may now proceed to notice their more important characteristics. These objects require to be studied under two aspects,—that of their shells, which are mere skeletons, partly external and partly internal; and that of their soft animals,—the living moving organization by which the shells are secreted. Owing to their abundance, and the readiness with which they may be obtained, the former of these have for above a century past attracted the chief, nay the almost exclusive, attention of naturalists. We, too, will first glance at their chief peculiarities.

In chemical composition they exhibit two very distinct types: first, those in which carbonate of lime is the chief ingredient; and, secondly, those in which sand, cemented together by some peculiar animal secretion, is the chief constituent. But we have also two kinds of calcareous structures. In the one which I have elsewhere termed porcelainous, the shell is white, semi-opaque, usually shining, exhibiting a rich amber-colour when viewed as a transparent object by transmitted light. Young shells of this class are at first somewhat transparent, but they soon assume the characteristic opaque aspect of mature forms.

In the other class of calcareous shells, termed hyaline, the transparent appearance is maintained to a much later period, and when age has rendered them opaque, they exhibit a dirty greenish tint instead of the lustrous whiteness of the porcelainous types; transmitted light also fails to reveal the amber tint of the latter shells.

Of the shells in which sand is a constituent element but little is known. The animal cement which binds the foreign particles together does not appear to be soluble in any alkaline solution, as is the case with the sarcode. Treated with a hot solution of caustic, the particles lost none of their cohesiveness, a fact suggesting a composition analogous to the chitinous integuments of insects and crustaceans. There are some forms in which this animal substance appears to compose the entire shell—unmixed with any inorganic matter.

Neither of these three varieties of organic composition appears to be limited to particular forms of shells. We find instances in which the same external contour presents itself under the porcelainous, the hyaline, and the arenaceous aspects. But there is one feature in which they appear to differ. We find all the maturer shells of the hyaline type displaying a laminated structure (fig. 14), the laminæ being added to the outer surface of the shell. The probable agency by which this has been effected will be better understood after describing the prevailing forms of the shells than now. Such laminæ do not appear conspicuously in the porcelainous and arenaceous types, so far as I have observed; suggesting some probable difference in their modes of growth.

In a very large number of the Foraminiferous shells, minute parallel unbranched tubes (fig. 14) pass through the shell-wall, establishing abundant communication between the exterior and interior of each shell. Occasionally these apertures are of considerable size, especially in young examples of some Rotalinæ, but in others they are so minute and densely crowded together as to require careful observation for their detection. It is from these tubes that the term Foraminifera has been derived. They are not, however, the only means of communication between the inner and outer shell-surfaces. In many of the hyaline types we have a much larger set of freely-branching tubes (fig. 15) distributed through the laminated shell-walls. These spread themselves through all the shell-walls, forming a free network where the shell is thick, as at its peripheral margin. In the latter localities, the canals are often of considerable size, giving off smaller branches, which penetrate even the thin septa separating the chambers. The tubes open abundantly upon the exterior of the shells, and, in a smaller degree, communicate with the internal cavities, being obviously designed to establish free communication between the two.

It is very difficult to convey by words a correct idea of the various shapes assumed by the Foraminifera. The simplest is that which appears to be the embryonic starting-point of all the types, viz., a small atom of gelatinous sarcode inclosed in a hard spherical covering composed of one or other of the three elementary substances already described, the sphere having a single orifice in some part of its periphery. In the majority of instances this proves but a rudimentary state, from which higher and more complex structures are evolved by a budding process, but in Orbulina, Gromia (fig. 3), and the graceful Lagena (fig. 4), it is the ultimate condition, the single segments receiving no further additions. But this is an exceptional state of things. Usually, additional segments are added, growing as buds or shoots out of the preceding one, each continuing attached to its predecessor by one or more narrow necks. It is to variations in the directions which these shoots assume that is due the diversified aspect of the Foraminiferous shells. In some the segments grow in a linear series, each new one being projected in a straight line, as in Nodosaria (fig. 5), or in a curved one, as in Dentalina (fig. 6). In Marginulina and Cristellaria (fig. 7) the growth is first spiral, then straight. In another group all the growths commence and continue in the spiral direction. The simplest of these is the Spirillina (fig. 9), where the creature merely extends itself in a spiral coil without any transverse constrictions, and, consequently, without any separation of its shell into chambers, after the pattern of the recent fresh-water genus of Mollusks, the Planorbis. But the spiral type is usually divided into segments. Occasionally the exterior of the shell is so smooth that the boundaries of the segments are only marked by white or translucent lines. But these boundaries are more frequently indicated by deep constrictions, especially when the shell is immature, giving the creature a lobate aspect. This latter form especially prevails amongst the Rotalinæ (fig. 8) and Nonioninæ. In another group (Textillariæ, fig. 11) the new segments are added in two parallel longitudinal series, alternating to the right and left of a central line, whilst in the genus Verneueilina there are three such series. The tropical seas furnish another type, not now found in our colder regions, though in the earlier Tertiary period they were as common here as they now are among the Coral Islands of the sunny south. This is the Orbitolites (fig. 10), in which, after a brief spiral growth, the new segments shoot out in one or more horizontal planes from all the circumference of the original germ, forming a beautiful circular disk, resembling, in their external aspect, the engine-turned back of a watch. This elegant form, common in the Tertiary sands of the Paris basin, was long regarded as a minute coral.

From these symmetrical forms we pass to another less regular group, conducting us by gradations to the unsymmetrical skeletons of the sponges. In the curious Tinoporus, the early spiral arrangement of the chambers is soon exchanged for a less regular clustering of new segments on all sides of the primary ones, but with some faint retention of a concentric arrangement; whilst in the Carpenteria we have not only a very irregular grouping of the segments, but the cavities of the latter are occupied by a spongiform body, containing silicious spicules, like those of some sponges. It is possible that these latter objects may be mere parasites; but if they are part of the Foraminiferous organism, which high authorities believe them to be, these animals supply a very remarkable link uniting the Sponges and Foraminifera. Under all circumstances, Carpenteria establishes such a connection, even though the specular skeleton proves to have no organic connection with it.

The only type whose growth remains to be noticed is that of the Miliolæ—a group of shells exhibiting in a strongly marked form the procelainous texture, and which have also an internal structure peculiarly their own. They are virtually long and more or less flattened tubes, wound round an oblong central axis, becoming much constricted where the tube bends round each extremity of the shell, or at each half-turn. Hence each convolution is longer than its predecessor. Sometimes these successive convolutions are arranged concentrically on one plane (Spiroloculina, fig. 13), at others they are added in a revolving one (Triloculina, fig. 14), an arrangement to which French naturalists have given the name of *pelotonée*, from its resemblance to the process of winding a thread upon an oblong ball of cotton. The Miliolæ have no foramina in their shell-walls for the transmission of pseudopodia; but this lack is compensated for by the large size of the terminal septal, or, as it is sometimes termed, oral aperture.

As I have already remarked, all the calcareous and arenaceous forms of shell that I have just described are to be regarded in the same physiological light as the calcareous and horny skeletons of sponges and corals. They are secreted by the soft gelatinous animal substance to which the name of Sarcode has been given, and to the nature of which attention may now be directed.

Sarcode is a translucent protoplasmic substance, having some condition of albumen as its base, but containing oil-globules in addition. It is remarkably plastic or ductile; capable of being drawn out into slender threads (figs. 1, 2, 3), which readily merge again into a continuous mass when they come into mutual contact. These pseudopodia, as the threads are termed, correspond very closely in this and other respects with the radiating protoplasmic bands seen in the body of the Noctiluca, which causes the sea waves to sparkle with phosphoric light, and with the curious radiating masses occurring in the more highly organized Rotifera. In the latter cases, the substance would appear to be a part of the protoplasm of the original ovum not used up in the formation of the organism, a circumstance that throws light upon the organization of the Foraminifera and their allies. Sarcode, therefore, is the lowest form of animal substance, approaching nearer to the contents of an ovum prior to their reorganization into tissues than any other known material. In the living Foraminifera sarcode is usually of a yellowish, but sometimes of a red colour, the tint being deepest in the older and more central segments. It seems probable that in all cases it can be entirely withdrawn within the hollow cavities of the shell-skeletons, whilst it can be freely extended in every direction at the will of the animal. Each type of shell appears to have its own characteristic arrangement of the pseudopodia. In some, such as the Miliolæ (fig. 1), the long plastic filaments radiate only from the one terminal orifice of the outermost and newest segment, there being, as we have seen, no apertures in their shell-walls through which pseudopodia could escape. But in the foraminated Rotalinæ and their allies (fig. 2) the filaments stream from all the numerous apertures with which the shell-wall is perforated, the thin film of the sarcode covering at the same time all the exterior of the shell. These prolongations of the sarcode are doubtless the instruments of locomotion, but they also appear to perform other organic functions. As they not unfrequently embrace and invest other objects, such as small Diatoms, we may conclude that they extract nutriment from the latter, as is the case with the Amœbæ and Sponges. The investing layer of sarcode to which I have referred also appears to be the instrument in effecting the enlargement of the shell-skeleton. So long ago as 1848,* as again in 1850,† I demonstrated that, unlike the Mollusca, the shells of the Foraminifera must increase by additions to their external surfaces, and that this plan necessarily involved the continuous extension of some part of the soft sarcode over those surfaces. Schultze's figure of a Gromia (fig. 3) thoroughly illustrates and confirms this early induction. It is most probable that as the pseudopodian threads protrude through the foramina, their bases become confluent outside the shell, and form the investing layer referred to. This explanation, if correct, brings the growth of these calcareous shells into close affinity with that of the skeletons of Sponges and Corals.

It thus appears that there are no special organs in the sarcode of any of the Foraminifera fulfilling nutritive or other functions, a fact which places them in close relationship with the lower types of Rhizopodous animals. We may next inquire what is known respecting their reproduction. On this point our information is very scanty, the meagre result of a few isolated observations. The late Dr. Mantell first called attention, in 1846, to some small globular bodies seen in connection with the soft parts of Foraminifera, and which he suggested might be ova. Curiously enough, this observation

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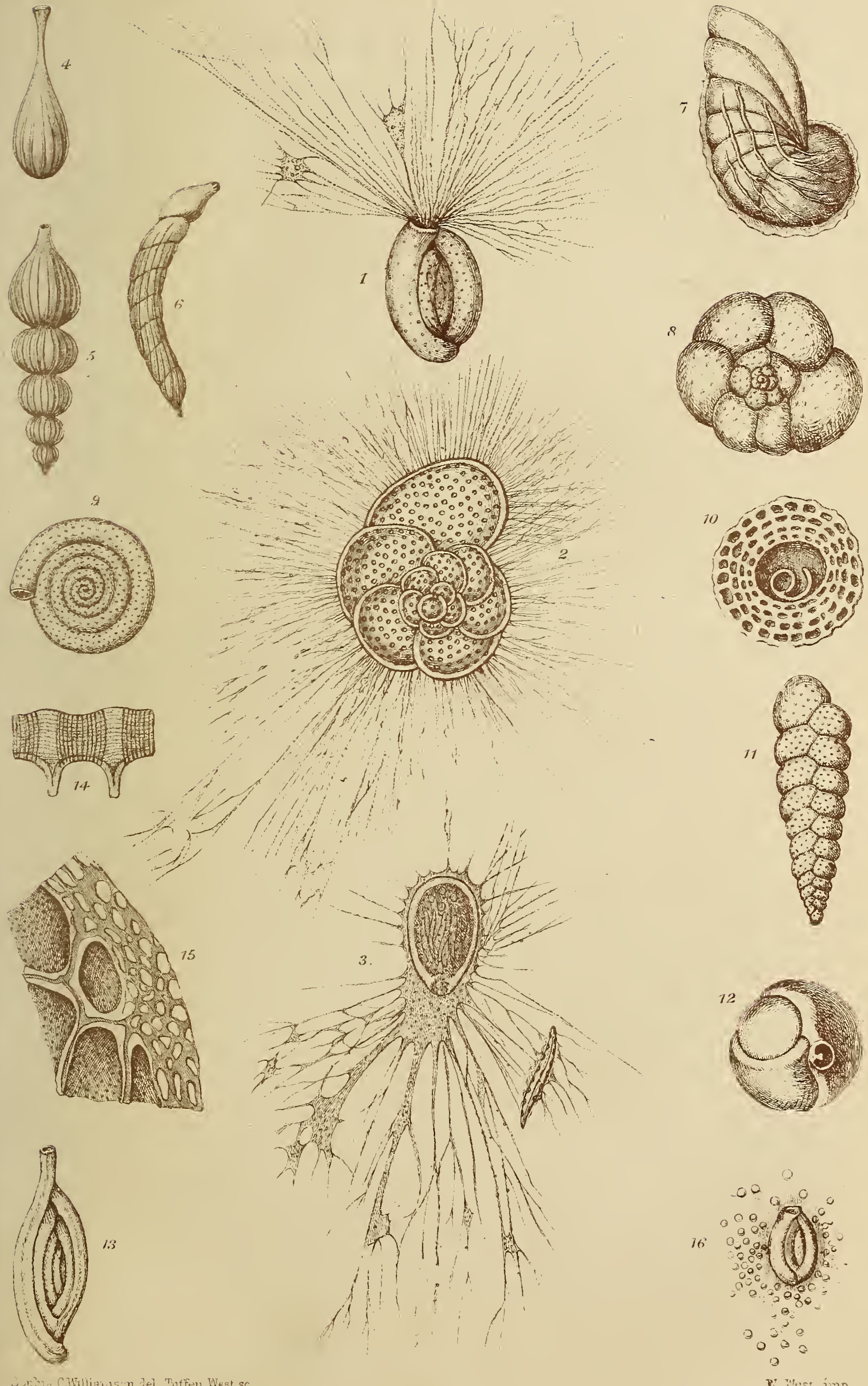
* Trans. Micros. Soc. London, vol. ii., "On the Structure of the Shell and Soft Animal of Polystomella crispa."

† *Idem*, vol. iii.



Sophia C. Williamson, del. Tuffen West, sc.

W. West, imp.

Foraminifera.

BRITISH MUSEUM
NATURAL HISTORY.

was made upon some fossil specimens preserved in chalk flints. Since then further indications have been obtained by Schultze, Dr. Carpenter, and Dujardin, but especially by the last-named observer. He found that some Miliolæ invested their shells with a brown slimy substance, in which small granules soon made their appearance (fig. 16), the latter soon succeeding in detaching themselves from the parent organism. In two or three weeks they developed into young shelled Miliolæ, which shortly afterwards threw out their characteristic pseudopodia and crawled about the glass in which they were preserved. An examination of the original shell showed that the production of the young brood had been at the cost of the life of the parent animal, the greater part of the sarcode having resolved itself into these granules. These changes coincide so closely with similar phenomena occurring in some other Rhizopods, that no doubt need be entertained respecting the accuracy of the observation. Whether any combinations of sperm and germ cells preceded this resolution into granules, indicating some higher process than mere budding, is yet unknown. In addition to the reproductive process just described, I long ago obtained evidence of a multiplication of the Foraminifera by some fission of the germ into two halves prior to calcification. I found several specimens in which calcification had commenced before the fission had been completed. These were objects in which the segments were normally arranged in one linear series; but in the examples referred to, two such series diverged from the primary or germinal segment,* both exhibiting the same external aspects and belonging to the same variety. We thus obtain indications of at least two modes in which the Foraminifera are multiplied. 1st. By resolution of the sarcode into reproductive germs; and 2nd, by the fission of these or some similar germs into two parts prior to calcification. The circumstance that the two halves of the twin specimens just spoken of belong to exactly the same variety, is sufficient proof that this fissiparous germination is not the source of the multiplied varieties which all the species of Foraminifera exhibit. Just as in the floricultural world, fission, or the separation of cuttings, is used to perpetuate the same variety, whilst seeds, products of sexual reproduction, are used as the source of new varieties; so in all probability it is amongst the Foraminifera. But whether the germs noted by Dujardin are those amongst which the new varieties spring up, or whether there remains some undiscovered mode of sexual reproduction, has yet to be ascertained.

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* See Foraminifera of Great Britain, tab. 1, fig. 32 a, and tab. 2, fig. 49.

Nothing in the study of these objects has proved more perplexing than the attempt to separate them into specific groups. Observers who, like D'Orbigny, merely selected a few prominent varieties, found no difficulties. They assigned to such types generic and specific names with a recklessness that was as unphilosophical as it was perplexing to those who followed them. When studying the British forms of Lagenæ, in 1847, I became satisfied that the old specific divisions were unsatisfactory. It was obvious that my predecessors had wholly misunderstood these objects, from their ignorance of the immense range of variation that each species was capable. But bold as many fellow-labourers deemed my innovations, they fell far short of what my subsequent inquiries, and those of Dr. Carpenter, Professor Rupert Jones, and Mr. Parker, have shown to be necessary. Consequently, in my memoir on the British Foraminifera I stated, that "the hard shells of the Foraminifera do not constitute a sufficiently constant and important element in their organization to justify our trusting to them as guides in the discrimination of species:" a conclusion that the elaborate inquiries of Messrs. Parker and Jones have done much to confirm. At present we can do little more than recognize what appear to be certain typical forms around which variable groups may be gathered; but even here we become involved in serious difficulties, since the various groups pass so gradually into each other that their boundaries become most uncertain; besides which, it will often remain a mere opinion what forms are to be regarded as the types and what the subordinate members of a group. There is abundant room for arbitrary selection on this as on every similar point connected with the classification of these obscure organisms.

Devoted as this sketch mainly is to the structure and physiology of the Foraminifera, little requires to be said respecting their geographical and geological relations. There are few parts of the ocean where they do not occur. Their dead shells are cast upon our shores. Some living kinds are found adhering to the roots of Laminariæ but a few feet below the low-water mark. They become still finer and more abundant as we pass into somewhat deeper waters, beyond which the individuals become more numerous, though the types become much fewer. This state of things culminates in the true habitats of the *Globigerina bulloides*, and its constant companion, the *Orbulina universa*. These two are thorough cosmopolites, being found from pole to pole and at every known depth; but their true home is in some of the deepest parts of the ocean, especially where the gulf-stream crosses the Atlantic, and in other similar localities in the southern world. Here these accumulating shells constitute masses of unknown extent and thickness, almost unmixed with either inorganic materials or with other organisms. They are forming raw material for the construction, in some remote future, of beds of calcareous rock, as closely allied varieties did countless ages ago, when our chalk-hills existed in like manner as a calcareous mud at the bottom of the Cretaceous sea. But in all probability the bond of similar conditions is not the only link that unites the present with the past. We find many of the species referred to exhibiting no material variations, notwithstanding the widely different conditions under which they exist. In shallow waters or in the depths of the Atlantic; in icy seas or under a tropical sun, they are ever the same. This indifference to external circumstances, arising out of their low organization, has enabled them to survive changes fatal to all animals of higher organization; and it is more than probable that many of the existing Foraminifera are the lineal descendants of an ancestry that lived so far back as the Triassic period, a pedigree that sets at nought every attempt to vie with the antiquity of their pedigree. Other and more conspicuous creatures have again and again succumbed before the physical changes that successive ages have brought about; but these little objects pursue their wonted course, and bid fair to do so as long as the world endures.

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2. Shell and soft animal of Discorbina (after Schultze) with the foramina in the shell-wall.
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4. Lagena vulgaris.
5. Nodosaria radicula.
6. Dentalina legumen var.
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10. Orbitolites, horizontal section (after Carpenter).
11. Textularia variabilis.
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13. Spiroloculina depressa var.
14. Section of laminated shell-wall of an Operculina, showing the pseudopodian tubes penetrating the laminæ.
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16. Parent Miliolina developing young germs (after Schultze).

WAVES OF HEAT AND WAVES OF DEATH.

BY B. W. RICHARDSON, M.A., M.D.

WHILE our sanitarians are busily occupied in pointing out those evils of our social condition on which many diseases rest that need never be seen or developed but for our own misdoings, and while it is our duty to listen to what they have to say, and to follow the simple precepts which they lay down for our guidance, it is well for us not to lose sight of the all-important fact that there are certain influences at work in the production of diseases over which the sanitarian has no control. In some senses, indeed, sanitary science, in the midst of great achievements, has, to a certain extent, been an obstruction to scientific progress. This is no paradox. When our first sanitary reformers commenced their great works they had such a strong case in their hands, they had such prominent evils to contend with, they had such flattering promises to offer, such rewards for the waiting hoping masses, and such triumphs for the zeal and labours of their own disciples, that when they once obtained a hearing they were heard to the exclusion of nearly all else. Oh ! the happy days that were to come,—the millennium of health, how near was its advent ! Henceforth we were not to cure diseases in detail, but to prevent them in phalanx. The epidemics were to be wiped out, and the nation that nurtured them was to be stamped uncivilized, gross, and dangerous,—a gigantic upas tree, infecting a world elsewise physically pure.

I, who have been one of the stanchest advocates of sanitary progress, cannot, I hope, be doubted in repeating that the results of sanitary work, although they have fulfilled much, have not been prosecuted without some disadvantage. I think that they have tended rather largely to damp the energies of many able and observant men in that line of medical inquiry which professes to *treat* disease; I fear they have thrown a cloud of scepticism over the whole art of *treating*; and I am certain they have given rise to the invention of sundry theories and speculations, which do not account for various common and all-important phenomena. But that which is most to be complained of is the tendency to which they have led, of ignoring pervading influences, active in the production of disease, and of supplementing the knowledge of these influences by referring forms of disease that have been observed to some *in*sanitary condition. From an unreasonable blindness to sanitary defects, we have gradually drifted into an equally unreasonable measurement of them. In regard to spreading diseases we hear now almost exclusively of one cause—*drains* and the smells thereof. The evidence is conclusive that certain disorders,—some forms of continued fever, for instance,—are due to emanations from sewers and drains; and it is possible that some of the other communicable diseases are, under special circumstances, communicated by the same emanations; but, after all, the drain is only one means for the propagation of a limited class of spreading disorders, and if we continue looking only into the drain for all this class, as we have been looking for some few years past, we shall lose by our devotion to the contemplation more than we ever gained by being first directed to that line of research. We will not forget the drain, however, nor the bad smell, nor bad water, nor uncleanliness in general, as causes of diseases. That would, indeed, be mistaken policy; but we will suppose all the drains pure, all the water unexceptionable, and every dwelling-house and the body itself clean, and what then? Physical millennium? No! Death finds dirt an ally, but he can do without it, and although cleanliness is sometimes his opponent, it is more commonly a neutral.

Without a word against sane sanitary science, I want on this occasion to point out that there are in nature certain agencies at work which determine many of our common and fatal diseases, and which lie apart from the ordinary social control of man, according to his present wisdom and acquirement. To put the matter in a very strong light, let us look at a man struck dead by a flash of lightning: that man did not die from any cause over which sanitary science could exert control; he died, and we all confess the fact, from the effects of an external force which is out of our hands: there is no reason why science should not ultimately be wise enough to come in and *restore* the man *after* the accident, but it could hardly make every necessary protection against the accident. Just as purely external in their origins, and invincible in their powers, are certain other outside agencies, which the sanitarian cannot touch. These agencies differ from the lightning flash, because they are more widely diffused, and, therefore, more inappreciable, but they are not the less outside and not the less unpreventible.

We may take in illustration of this fact, the most frequent disease,—common cold. Whence comes it? Why should a fourth of England wake in the morning with cold? Why, for some weeks past, should sore throat have been so prevalent that scarcely any one could be met who, on inquiry, would not be found with the back of the throat unduly red, and the tonsils large? Why, in a given village or town, shall the medical men be summoned on some particular day to two or half-a-dozen places perhaps at once, to visit children with croup? What is the reason that many cases of sudden death, by so-called "apoplexy," crowd together into a few hours? Why in a given day or week are shoals of the aged swept away, while the young live as before? These are questions which are above the answering of curative and preventive medicine alike. Curative medicine, if her interpreter be honest, at the name of them, stands abashed; and preventive medicine says, if her interpreter be true, "The questions are as yet out of my range."

Still, we are not altogether ignorant: some circumstances appear to be followed by effects so definite, that we may almost consider we have them before us, in an obscure picture of cause and effect. It will be profitable to look at this picture, and try to make it out from various points of view; but I must confine myself to one point now, viz., to *the simple influence of a low wave temperature on life.*

If we carefully observe the fluctuation of the thermometer by the side of the mortality of the nation at large, no very remarkable relationship seems to be traceable between the one and the other. But if, in connection with the mortality, care be taken to isolate the cases, and to divide them into groups according to their ages, a singular and significant series of facts follow, which show that after a given age a sudden decline of the temperature influences mortality by what may be considered a definite law. The law is, that up to the age of thirty years variations of temperature exert no influence on the mortality of the population generally; but after the age of thirty is reached, then a fall of temperature, which is sufficient to cause an increased number of deaths, acts in a given manner,—as it may be said in waves or lines of intensity, according to the years of the people. If we make these lines nine years long, we discover that they double in force at each successive point. Thus, if the fall in the temperature be sufficient to increase the mortality at the rate of one person of the age of thirty, the increase will run as follows:—

One death at thirty years of age.
Two deaths at thirty-nine years of age.
Four deaths at forty-eight years of age.
Eight deaths at fifty-seven years of age.
Sixteen deaths at sixty-six years of age.
Thirty-two deaths at seventy-five years of age.
Sixty-four deaths at eighty-four years of age.

In these calculations nothing seems to be wanting that should render them trustworthy; they result from inquiries conducted on the largest scale; they have been computed by our greatest authority in vital statistics, and they accord with what we gather from common daily observation; they supply, in a word, the scientific details and refinements of a rough estimate founded on universal experience, and they lead us to think very gravely on many subjects which may not have occurred to us before, and which are as curious as they are absorbing.

We often hear small moralizers, who know little or nothing about vital phenomena—by which term I mean nothing mysterious, but simply the physics embraced in those phenomena which we connect with form and motion under the generic term, life,—we often hear, I say, small moralizers harp on the one string, that man knows nothing of the laws of life and death. But what an answer to such presumption of ignorance do the facts rendered above supply! Why, life and death are here reduced on given conditions to reasonings as abstract and positive as are the reasonings on the atomic theory, or the development of force by the combustion of fuel. It is not necessary for the vital philosopher to go out into the towns and villages to take a new census of deaths to enable him to give us his readings of the general mortality under this one specific state. He may sit in his cabinet now, and as he reads day by day his thermometer, predict results. There is a fall of temperature that shall be known by experience to be sufficiently deep and prolonged to cause an increase of one death in a given community amongst those who have reached thirty years. Is it so? Then there have died sixty-four, in proportion to that one of those who have reached eighty-four years. This is a good reflection, and it leads to another reflection, not so good. It leads one to ask what, if the law be so definite, are curative and preventive medicines doing meanwhile, that they should not disturb it? I fear that they do not even produce perturbations, and I do not see how they could at this moment; because, as the truth opens itself to the mind, the enormous external change in the forces of the universe that leads to the result, is not to be grappled with or interfered with on any efficient known method of human kind or invention. The cause is too general, too overwhelming, too grasping. It is like the lightning stroke in its distance from our command; but it is diffused, not pointed and concentrate; prolonged, not instantaneous; and, by virtue of these properties, it is so much the more subtle and devastating.

At first it seems very easy to explain the reason why a sudden fall in temperature should lead to an increase in the number of deaths, and it is to be admitted that to a certain extent the reason is clear. Without entering on the question which the old Greeks so warmly contended for—Heraclitus above them all—that heat is the animating principle of all living organisms, we may accept that in the evolution of force from the body, as represented by its power of producing force in the form of heat, we have a measurement of the capacity of the body to sustain force, which is only another phrase for expressing the resistance of the body to death. For example, if we assume that a healthy man of twenty-nine years, respires four hundred and fifty cubic feet of air per day, and by combustion of his carbon, evolves as much heat as would raise fifty pounds of water at 32° Fahr. to 212° Fahr. under all ordinary temperatures, which is about the fact, and if we assume that another man at thirty-nine shall not be able at any temperature to respire so much air, and shall not be able to evolve as much caloric as would raise forty-four pounds of water from 32° to 212° we see a general reason why the latter man should feel an effect from a sudden change in the temperature of the air which the younger man would not feel; and if we assume, further, that a man at eighty-four, in the same time would evolve as much force as would raise only eleven pounds of water from 32° to 212°, we see a general reason that he should suffer much more from a decrease of external temperature than either of the two younger men.

It behoves us, however, to know more than this general statement of an approximate fact: we ought to understand the exact method by which the reduction of temperature influences, and the details of the physiological processes that are connected with the phenomena. I will try and explain these clearly, although I know they are not easy of explanation. When a human body is living at the age where the period of growth has ceased and the period of decay has not commenced, and when it is quite healthy, it generates, by its own chemical processes, so much heat or force as shall enable it, within given bounds, to move its own machinery, to call forth at will a limited measure of extra force which has been lying latent in the organism, and to supply a fluctuating loss that must be conveyed away by contact with the surrounding air, by the earth, and by other bodies that it may touch, and which are colder than itself. There is thus evolved in the body, *applied* force, *reserve* force, and *waste* force, and these distributions of the whole force generated, when correctly applied, maintain the perfect organism in such balance that life is true and steady. So much active force carries with it the power to perform so much labour; so much reserve force carries with it the power to perform a measure of new or extra labour to meet emergencies; so much waste force enables the body to resist the external vicissitudes without trenching on the force that is always wanted to keep the heart pulsating, the chest heaving, the glands secreting or excreting, the digestive apparatus moving, and the brain thinking or receiving.

Let us, even in the prime of manhood, disturb this distribution of force ever so little, and straightway our life, which is the resultant of force, is disturbed. If we use the active force too long, we become exhausted, and call on the reserve; if we continue the process, the result is failure more or less perfect, sleep, and, in the end, the last long sleep; let us, instead of exhausting the force, cut it off at the sources where it is generated; let us remove the carbon or coal that should go in as fuel-food, and we create prostration, and in continuance a waning animal fire, sleep, and death; or let us, instead of removing or withdrawing the supply of fuel, cut off the supply of air, as by immersion of the body in water, or by making it breathe a vapour that stops the combination of oxygen with carbon,—such a vapour as chloroform,—and again we produce at once prostration, sleep, or death, according to the extent to which we have conducted the process. Lastly, if instead of using up unduly the active and reserve force, or instead of suppressing the evolution of force by the withdrawal of its sources, we expose the body to such an external temperature, that it is robbed of its heat faster than it can generate it;—if, that is to say, to supply the waste heat, we draw upon the active and reserve forces, we call forth immediately the same condition as followed from extreme over-exertion, or from suppression of the development of force: we call forth exhaustion and sleep, and, in extreme case, death.

We have had in our mind's eye, in the above description, a man in the prime of life, in the centre of growth, and decay. In regard to the force of animation in him, we may look at him now retrospectively and prospectively. In his past his has been a growing developing body, and in the course of development he has produced an excess of force commensurate with the demands of his growth; this enables him to bear a certain excess of fatigue and exposure, without exhaustion and even with ease, until he has reached his maximum. When he stops in development, when he stands on a fair level with the external forces that are opposed to him, then his own force, for a short time balanced, soon sinks to be second in command. He feels cold more tenderly; if his rest be broken the demand for artificial heat is urgent; if he lose or miss food, he fails quickly; and, returning to our facts, as to the influence of the external temperature on mortality, these are the reasons why a fall in the thermometer sweeps away our population according to age so ruthlessly and decisively.

If we analyze the facts further by the side of the diseases which kill, we find those diseases to be numerous in name, but all of one type; they are diseases which of themselves tend either to produce undue loss of force, or that tend to prevent the development of force at its origin. Disorders which are accompanied with exhaustive loss of fluids from the body, such as diabetes, dropsies, and hæmorrhages are of the first class; disorders in which due supply of air to the lungs is prevented, are of the second class, especially chronic bronchitis, which is in truth the assigned cause of two-thirds at least of the deaths that succeed immediately on the fall of the thermometer.

In what has been written above I have stated simply and in open terms the fact that the fall of temperature produces a specified series of results, by reducing the force of the living organism, and disposing it to die. We may from this point investigate the mode by which the effect is produced in the economy in a physiological point of view. How does the decline of temperature act? Is the process simple or compound?

The process is compound, and into it there enter three elements. In the first place, the body is robbed rapidly of its waste force, and the reserve and active elements of force are consequently called upon to the depression of the organism altogether. This obtains because the medium surrounding the body, the air, unless it be artificially heated, receives from its contact with the body a larger proportion of heat than can be spared; and it might be possible to produce such an influence on the body by sudden extraction of its heat as to destroy it at once by the mere act. A man, as Metcalfe has remarked, a man half plunged into a bath of freezing mercury would die instantaneously, as from shock, by the immediate extraction of his heat. But in ordinary cases, and under ordinary circumstances, the mere rapid extraction of heat is not sufficient to account for all the mischief produced by a low temperature; for we take measures, by the use of non-conducting clothing, to counteract the mischief, and that, too, in a manner which proves pretty successful. We may, therefore, leave this element of extraction of heat as most important, but not all effective for evil.

The second element is the effect on the process of oxidation of blood. We all are aware that if a portion of dead animal or vegetable matter be placed at a low temperature, it keeps for a considerable time; and we have evidence of dead animals which, clothed in thick ribbed ice, have been retained free from putrefaction for centuries. Those ghastly bodies that occupy the dead-house of Mount St. Bernard on the Alps have lost water by evaporation, and are dried; but they are not putrid: they are preserved by cold, which means absence of heat. Hence we say that cold is an antiseptic as alcohol is, and chloroform, and ammonia, and creasote, and sulphurous acid, and other similar substances. Cold is an antiseptic, then, but why? Because it prevents, as do the bodies named a moment ago, the union of oxygen gas with combustible matter. The molecules of oxygen, in order that they shall combine, and in their combination evolve heat, require to be distributed, and are distributed by the force or motion known as heat: deprive them of this force, and they come into communion with themselves, are attracted to each other, and lose to the extent of this attraction their power of combining with the molecules of other bodies for which they have an affinity. In an analogous, but more obvious way, we may see the same effect of motion in the microscopic examination of blood. In the blood, while it is circulating briskly in its vessels, there are distributed through it, without contact with each other, millions of small round bodies, called blood corpuscles. In the circulation in the free channels of the body, the arteries and veins, it is motion that keeps these corpuscles apart: we draw a drop of blood and let it come to rest on the microscope glass, and as the motion ceases the separated corpuscles run together, and adhere so firmly that we cannot separate them by any force less than disintegration. If we were to drive them in this state round the body, through the vessels, they would not combine readily with the tissues; they have, in fact, forfeited the condition necessary for combination. So with oxygen, when its invisible molecules are deprived of the force called heat, which is motion, they do not readily combine with new matter. But perfect combination of oxygen and carbon in the blood is essential to every act of life. In the constant clash and union of molecule of oxygen with molecule of carbon in the blood lies the mainspring of all animal motion; the motion of the heart itself is secondary to that. Destroy that union, however slightly, and the balance is lost, and the organic body is, in a plain word, *ill.*

Cold, or decreased temperature, below a given standard, which for sake of comparison we may take at a mean of 55° Fahrenheit, does destroy this combination of oxygen and carbon in blood. In the Lettsomian lectures of the Medical Society of London, delivered four years ago, I entered very fully into this subject, and illustrated points of it largely by experiment. Since then I have done more, and although I have not time here to state the details of these researches, I will epitomize the principal facts. I found then that, by exposing blood in chambers into which air could pass in and out, the blood could be oxidized at temperatures of 70° if the distribution of air and blood were effectually secured, and I also found a given standard of oxidation from a given temperature. Then I proceeded to test for combination at lower temperatures, and discovered a gradually decreasing scale until I arrived at 40° Fahr., when combination ceased altogether. Of course, my method was a very rude imitation of nature, but it was sufficient to show this fair and reliable result, that the oxidation of blood is arrested as the temperature of the oxygen decreases.

From this point I went to animal life itself. I exposed animals to pure cold oxygen and to cold atmospheric air, and compared the results with other experiments in which animals of similar weight and kind were exposed to warm air and warm oxygen. The facts gleaned were most important, for they proved conclusively that the products of combustion, that is to say, the products resulting from the union of oxygen and carbon, were reduced in proportion as the temperature of the oxygen was reduced. In the course of this inquiry another singular and instructive fact was elicited. It has been long known that at ordinary temperature, say 60°, pure neutral oxygen does not support animal life so well as oxygen that is diluted with nitrogen. In the nitrogen the molecules of oxygen are more freely distributed under the influence of motion, that is the meaning of the observed fact. What, then, would be the respective influence of low and high temperatures on the respiration of pure oxygen? To settle this question, animals of the same size, kind, and weight were placed in equal measures of oxygen gas and common air at a temperature of 20° Fahr., and with the inevitable result that the animal in the pure oxygen ceased to respire one-third sooner than did the animal in common air. Carrying the inquiry further, I found that if the oxygen gas were warmed to 50° Fahr., the respiration was continued six times as long as in the previous experiment, while if the warming were carried to 70° it was sustained twenty-four times as long.

I need not carry this argument further; it is the easiest of the demonstrative facts of physiological science that the reduction of temperature lessens the combining power of oxygen for blood, and therewith causes a reduction of animal force, and a tendency to arrest of that force, *death*.

The third element in the action of cold is purely mechanical, and though in a sense secondary is of immense import. When any body, which is capable of expansion by heat, that is to say, by radiant motion of its own particles, is reduced in temperature, it loses volume, and contracts or shrinks. The animal body is no exception to this rule: a ring that will fit tightly on the warm finger will fall off the same finger after exposure to cold. The whole of the soft parts shrink, and the vessels contract and empty themselves of their blood. Cold applied to the skin in an extreme degree blanches the skin, and renders it insensible and bloodless. If we prick it, it does not bleed, neither does it feel. In cases where the body altogether is exposed to extreme cold this shrinking of the external parts is universal: the whole surface is pale and insensible; the blood in the small vessels superficially placed is forced inwards upon the heart and vessels of the interior organs; the brain is oppressed with blood; sleep, or coma, as it is technically called, follows, and at last life is suspended.

In exposure to the lowest wave of temperature in this country these extreme effects are not commonly developed: but minor effects are brought out which are most significant. In particular, the effect on the lungs is marked. The capillary vessels of the lungs, of that fine network which plays over the computed six hundred millions of air vesicles, undergo rapid contraction when the cold air enters the lungs; in proportion as such contraction is decisive, the blood that should be brought to the air vesicles is cut off and the process of oxidation is thus mechanically as well as chemically suppressed. The same contraction is also exerted on the vessels of the skin, driving the blood into the interior and better protected organs. Hence the reason why on leaving a warm room to enter a cold frosty air there is an immediate action of the renal organs from pressure of blood on them, and not unfrequently a tendency to diarrhœa from temporary congestion of the digestive tract. Three factors then are at work whenever the low wave of temperature surrounds the animal organism: abstraction of heat from the body, and beyond what is natural; arrest of chemical action and of combustion; mechanical contraction of the vessels most exposed.

We cannot view the extent of these changes in the organic life, as induced by the low wave of heat, without seeing at once the sweep of mischief which exposure to the wave may effect. It exerts an influence on healthy life in the middle-aged man, and I know of no disease which it does not influence disastrously. Is the man healthy, it tends to produce internal congestion; has he a weak point in the vascular system of his brain, it renders that point liable to pressure and rupture, with apoplexy as the sequence; is he suffering from bronchial disease, and obstruction already in his air passages, here is a means by which the evils are doubled; has he a feeble worn heart, it is unable to bear the pressure that is put upon it; has he partial obstruction of the kidney circulation, he is threatened with complete obstruction; is he indifferently fed, he is attacked with diarrhœa. It is from this extent of action that the mortality of all diseases runs up so fast, when the low wave of heat rolls over the population, taking, as we have seen, the feeblest first.

Another danger sometimes follows which is remote, but may be fatal, even to persons who are in health. It is one of the best known facts in science that when a part of the outer surface of the body has been exposed long to cold, the greatest risk is run in trying suddenly to warm it. The vessels become rapidly dilated, their coats give way, and extreme congestion follows. But what is true of the skin is true equally, and with more practical force, of the lungs. A man, a little below par, goes out when the wave of temperature is low, and feels oppressed, cold, weak, and miserable; the circulation through his lungs has been suppressed, and he is not oxidizing: he returns to a warm place, he rushes to the fire, breathes eagerly and long the heated air, and adds perchance to the warmth by taking a cup of hot drink; then he goes to bed and wakes in a few hours with what is called pneumonia, or with bronchitis, or with both diseases. What has happened? The simple physical fact of reaction under too sudden an exposure to heat after exposure to cold. The capillaries of the lungs have become engorged, and the circulation static, so that there must be reaction of heat,—inflammation,—before recovery can occur. Nearly all bronchial affections are induced in this manner, not always or necessarily in the acute form, but more frequently by slow degrees, by repetition and repetition of the evil. Common colds are taken in this same way: the exposed mucous surfaces of the nose and throat are subjected to a chill; then they are subjected to heat; then there is congestion, reaction of heat, pouring out of fluid matter, and all the other local phenomena.

The wave of low temperature rolling over a given population finds inevitably a certain number of persons of all ages and conditions on whom to exert its power. It catches them too often when they least expect it. An aged man, with sluggish heart, goes to bed and reclines to sleep in a temperature say of 50° or 55°. In his sleep, were it quite uninfluenced from without, his heart and his breathing would naturally decline. Gradually, as the night advances, the low wave of heat steals over the sleeper, and the air he was breathing at 55° falls and falls to 40°, or it may be to 35° or 30°. What may naturally follow less than a deeper sleep? Is it not natural that the sleep so profound shall stop the labouring heart? Certainly. The great narcotic never travels without fastening on some victims in this wise, removing them, imperceptibly to themselves, into absolute rest, inertia, until life recommences out of death.

The study of the physiological influence of the wave of low heat, and of its relation to the wave of mortality suggests two series of thoughts.

In the first place, it leads us to ask what are the best means of meeting the wave of low temperature? Necessarily all rules will be but imperfect, even though they be carried out perfectly; but there are a few which are simple, easy to be remembered, and of value.

(*a.*) Clothing is the first thing to attend to: to have the body, during variable weather, such as now obtains, well enveloped from head to foot in non-conducting woollen substance is essential: who neglects this precaution is guilty of a grievous error, and who helps the poor to clothe in flannel does more for them than can readily be conceived without careful attention to the subject we have discussed in all its details.

(*b.*) In sitting-rooms or in bed-rooms it is equally essential to maintain an equable temperature; a fire in a bed-room is of first value at this season, and he who could invent an apparatus that would sustain a small bed-room fire in an open grate all night would be a true benefactor to his race, and soon a rich benefactor to boot. The fire sustains the external warmth, encourages ventilation, and gives health not less than comfort.

(*c.*) In going from a warm into a cold atmosphere, in breasting the wave of low temperature, no one can harm by starting forth thoroughly warm. A cup to *keep out* the cold may be added also with advantage. But in returning from the cold into the warm the act should always be accomplished gradually, and the cup to *relieve* the cold should be scrupulously avoided. This important rule may readily be borne in mind by connecting it with the recollection of the fact that the only safe mode of curing a frozen nose is to rub it with ice, and to restore the temperature as slowly as possible.

(*d.*) The wave of low temperature requires to be met by good, nutritious, warm food. Heat-forming foods, such as bread, sugar, butter, and potatoes, are, in moderation, of special use now. It would be against science and instinct alike to omit such foods when the body requires waste heat urgently and abundantly.

(*e.*) It is an entire mistake to suppose that the wave of cold is neutralized in any sense by the use of alcoholics. When a glass of hot brandy-and-water warms the cold man, the credit belongs to the hot water, and any discredit that may follow to the brandy. So far from alcohol meeting the cold in action, it goes with it: alcohol stops oxidation, and acts as an antiseptic, so does cold: alcohol stops generation of heat, and therewith the motion of the heart in the living animal because it stops oxidation, and cold does the self-same thing.

(*f.*) Excessive exercise of the body, and overwork either of body or of mind, should be avoided, specially during those seasons when a sudden fall of temperature is of frequent occurrence. For exhaustion, whether physical or mental, means loss of motion in the organism; and loss of motion is equivalent to, nay, is the same as, loss of heat.

In the second place, the subject of this paper has some reference to the bearing of the public towards the labours of medical men who have to meet the effects of the low wave of heat. The public, looking on the doctor as a sort of mystic or high priest who ought to save, are too often dissatisfied with his work. Let the dissatisfied think of what is meant by *saving* when there is a sudden fall in the thermometer. Let them recall that it is not bronchitis as a cause of death, nor apoplexy, nor heart disease, as such, that the doctor is asked to oppose, but an all-pervading influence which overwhelms like the sea, and against which, in the mass, individual effort stands paralysed and helpless. When the doctor is summoned the mischief has at least commenced, and, it may be, is over, while treatment by mere medicines sinks in every case into secondary significance. Writing now to the public and not to the profession, I am of all things anxious to place this last part of my subject forcibly before them, that they may know how to be charitable to those who are called upon to minister to health, and may not laugh down those ministers who are candid enough to bow humbly before the great and inevitable truth, and who, professing no specific cure by nostrum or symbol, try to lead towards recovery by teaching elementary principles, and by making the unlearned the participators in their own learning.

The title of this paper, suggested to me by the accomplished editor of the Popular Science Review, would afford scope for a much more elaborate essay. Waves of high temperature have their specific influence also, encouraging some diseases and arresting others. I must not be tempted here to enter on this wider field, but catching the very cold inspiration of the season, must perforce, sternly as my mistress Nature herself, leave the good reader to console himself, as best he may, with that which is before him.

ORIGIN OF OUR KITCHEN GARDEN PLANTS.

BY HARLAND COULTAS,

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FOR a long time it was thought to be impossible to discover the origin of those nutritive species of plants commonly cultivated by man; some writers maintaining that their primitive habitat had been destroyed, that they originated on lands over which the ocean now rolls its waters, whilst others, equally fanciful, supposed a miraculous intervention of the Deity, and that man received directly from the gods the first seeds of the cerealia and other plants, which he cultivates as sources of food. The prevailing opinion upon this great question, even among enlightened persons, and so late as the commencement of the present century, may be gathered from the following passage from Humboldt's Essay upon the Geography of Plants (*Essai sur la Géographie des Plantes*, 1807, p. 28):—

> The country in which originated the vegetables most useful to man is a secret as impenetrable as the first dwelling-place of our domestic animals. We are ignorant of the country in which the grasses first originated which furnished nutriment to the Mongolian and Caucasian races. We know not in what country our cerealia grow spontaneously—our wheat, oats, and rye. The plants which constitute the natural riches of the inhabitants of the tropics, the banana, papaw, cassava, and maize, have never yet been found in a wild state. The potato presents the same phenomena.

Since the time when the above passage was written by this illustrious author, the wild potato has been found growing in the greatest abundance in South America; the papaw, by Marcgraaf, in the forests of Brazil; and Olivier and Bruguières, in travelling through Western Asia—the cradle of the European race—have found wild rye and barley. Thus year by year the progress of geographical and botanical researches conduces to more certain and simple ideas on the origin of cultivated plants, so that our best naturalists now, instead of supposing, as formerly, miraculous phenomena, or revolutions in the physical geography of the planetary surface, are all agreed that it is highly probable that all our cultivated plants have originally descended from some wild form; and that probably some day, at no very distant period, we shall know in a spontaneous state the immense majority, perhaps the totality of our cultivated species.

M. Alphonse de Candolle gives a list of 157 plants, which he selects because most commonly cultivated by man, and of these 85 have been found wild—that is to say, identical with the cultivated plant, or at least with some of its varieties. If to these species are added those which are most probably wild, or about which hardly a doubt remains, we may consider 117 as having been identified in a spontaneous state. In short, the species which we historically know to have been first cultivated in Europe, have been found wild in Europe; and those cultivated species of which the wild form has not yet been found, are all foreign plants cultivated abroad, and in countries which have not yet been explored.

The following is the list of cultivated plants, given by De Candolle, of which the wild forms have been found, 85 in number, and here inserted as likely to be interesting to our readers :—

Potato, *Solanum tuberosum*, L.
Five-leaved Yam, *Dioscorea pentaphylla*, L.
Bulb-bearing Yam, *Dioscorea bulbifera*, L.
Prickly Yam, *Dioscorea aculeata*, L.
Deltoid-leaved Yam, *Dioscorea deltoidea*, Wall.
Ipomœa mammosa, Choisy.
Field Cabbage, *Brassica campestris*, L.
Turnip, *Brassica rapa*, L.
Rape, *Brassica napus*, L.
Radish, *Raphanus sativus*, L.
Carrot, *Daucus carota*, L.
Parsnip, *Pastinaca sativa*, L.
Rampion, *Campanula rapunculus*, L.
Garlic, *Allium sativum*, L.
Madder, *Rubia tinctorium*, L.
Indian Hemp, *Cannabis sativa*, L.
Lucern, *Medicago sativa*, L.
Sainfoin, *Onobrychis sativa*, Lam.
Clover, *Trifolium pratense*, L.
Cabbage, *Brassica oleracea*, L.
Succory, *Cichorium Intybus*, L.
Endive, *Cichorium endivia*, L.
Dock, *Rumex patientia*, L.
Common Sorrel, *Rumex acetosa*, L.
Onion, *Allium cepa*, L.
Tea, *Thea Chinensis*, Lour.
Paraguay Tea, *Ilex Paraguariensis*, St. Hil.
Indigo, *Indigofera argentea*, L.
Coca, *Erythroxylon coca*, Lam.
White Mulberry, *Morus alba*, L.
Black ditto, *Morus nigra*, L.
Hop, *Humulus lupulus*, L.
Saffron, *Crocus vernus*, L.
Sweet Sop, *Anona squamosa*, L.
Sour Sop, *Anona muricata*, L.
Custard Apple, *Anona reticulata*, L.
Citron, *Citrus medica*, Gall.
Lemon, *Citrus Limonium*, Gall.
Mangosteen, *Garcinia mangostana*, L.
Mammee Tree, *Mammea Americana*, L.
Grape, *Vitis vinifera*.
Cashew Nut, *Anacardium occidentale*, L.
Strawberry, *Fragaria vesca*, L.
Dewberry, *Rubus idœus*, L.
Common Cherry, *Prunus avium*, L.
Morell Cherry, *Prunus cerasus*, L.
Plum, *Prunus domestica*, L.
Bullace, *Pruna institia*, L.
Apricot, *Prunus Armeniaca*, L.
Almond, *Amydalus communis*, L.

Pear, *Pyrus communis*, L.
Apple, *Pyrus malus*, L.
Quince, *Cydonia vulgaris*, L.
Pomegranate, *Punica granatum*, L.
Jambosa Malaccensis.
Bottle Gourd, *Lagenaria vulgaris*, L.
Egg-shaped Gourd, *Cucurbita ovifera*, L.
Melon, *Cucumis melo*, L.
Red Currant, *Ribes rubrum*, L.
Olive, *Olea Europea*, L.
Lucuma mammosa, Goertner.
Papaw Tree, *Papaya vulgaris*, D.C.
Date Palm, *Phœnix dactylifera*, L.
Banana, *Musa sapientum*, Br.
Pine Apple, *Bromelia ananas*, L.
Wheat, *Triticum vulgare*, L.
Spelt, *Triticum Spelta*, L.
Barley, *Hordeum distichon*, L.
Rice, *Oryza sativa*, L.
Tartarian, *Polygonum tartaricum.*
White Lupine, *Lupinus albus*, L.
Egyptian Lupine, *Lupinus Thermis*, L.
Great Blue Lupine, *Lupinus hirsutus*, L.
Field Pea, *Pisum arvense*, L.
Common Pea, *Pisum sativum*, L.
Vetchling, *Lathyrus sativus*, L.
Flat-podded Vetchling, *Lathyrus Cicera*, L.
Common Vetch, *Vicia sativa*, L.
Gold of Pleasure, *Camelina sativa*, L.
Walnut, *Juglans regia*, L.
Chocolate, *Theobroma cacao*, L.
Cocoa-nut, *Cocos nucifera*, L.
Coffee, *Coffea arabica*, L.
Cotton, *Gossypium punctatum.*

Having made these introductory remarks, we now confine ourselves to an inquiry into the origin of the kitchen garden plants of the United Kingdom. We select for this purpose such vegetables as are in ordinary use during winter ; in fact, our common Christmas vegetables will furnish an abundance of interesting material for discussion.

Our kitchen garden plants may be subdivided into—1. Those plants which are cultivated for the nutritive material in their rhizome, as the potato, parsnip, carrot, turnip, and horseradish. 2. Those plants which are cultivated for their stems, leaves, and flowers, as celery and the different varieties of the garden cabbage. We begin with that well-known vegetable,

The Potato (*Solanum tuberosum* L.).—This plant belongs to the natural order Solanaceæ, and is closely related to the tobacco plant, belladonna, henbane, nightshade, and other poisonous narcotics. But although the same poisonous principles exists in the potato plant, it is confined to its stem, foliage, and fruit, and is wholly absent from its roots or underground tubers, the parts of the plant used as food. When potatoes still attached to the growing plant become exposed to the light, the epidermis assumes a greenish colour, and the poisonous principle then develops itself. Such potatoes are totally unfit for human food. The potato plant has a stem from one and a half to two feet high, with interrupted pinnate leaves, which are composed of from five to seven pairs of lanceolate oval leaflets, having lesser ones between them ; the flowers are bluish-white, with orange-yellow, slightly cohering anthers, which are succeeded by a green globose berry, about half an inch in diameter. The tubers or potatoes produced by the plant are simply subterranean branches, arrested and thickened in their growth, in place of being elongated. The common idea that all the subterranean portions of a plant are roots, is quite erroneous; for the production of leaf-buds or leaf-scars are the distinguished characteristics of a stem wherever situated; and that the tuber or potato is a true stem is proved by the eyes on its surface, which are true leaf-buds. Hence the potato is propagated by cutting the tuber into pieces, when each piece, provided it has an eye, will grow and become an independent plant.

The potato is a native of South America, and is found in abundance wild in the mountainous regions of Chili, Peru, and the neighbourhood of Buenos Ayres. Its presence in Mexico, Virginia, and the Carolinas, where it was subsequently found, is probably not very ancient. It is thought that it may have been introduced there from South America by the first Spanish settlers. The potato was first grown by Sir Walter Raleigh, at Youghal, in Ireland, in 1586. The samples planted came from the Carolinas. The gardener who planted the tubers thought that the green potato apples were the potatoes, and carried them to his master, expressing his great disgust at such produce. Sir Walter, pretending to sympathize, told him to dig up the useless weeds, and throw them away. The gardener, in rooting out the plants, found the true potatoes, more than a bushel of them, and hurried back to his master in a very different humour, to show him the samples, and make known his discovery.

The soil and climate of Ireland are very favourable to the growth of good potatoes, and the plant appears to have rapidly grown into favour in Ireland, and was cultivated there as food long before its value was acknowledged in Great Britain.

In both England and Scotland a prejudice against it existed owing to the poisonous character of the plants of the natural order to which it belongs and the resemblance of its flowers to those of the woody nightshade (*Solanum dulcamara*), an extremely common plant, well known to be poisonous. Almost everywhere the same prejudice prevailed; in France, especially, and it was not until a time of great scarcity, during the Revolution, that its culture in that country became general.

For more than a century and a half after its cultivation by Sir Walter Raleigh in Ireland, the potato was cultivated in flower gardens only in both England and Scotland. Even in 1725 the few potato plants in the gardens about Edinburgh were left in the same spot from year to year. No attempt was made at a more extended culture. In 1728, however, a Scotch day-labourer, named Thomas Prentice, living near Kilsyth, Stirlingshire, carefully cultivated the potato as food, and, after supplying the wants of his own family, sold the remainder of the produce to his neighbours, who very willingly paid him his own price, being convinced by his example that potatoes were wholesome and nutritious. Prentice was frugal and industrious, and soon found himself in possession of £200, no small fortune in those days. He now sank his capital in an annuity at a good interest, upon which he lived independently in his old age, dying in the year 1792, at the advanced age of 86—(potatoes evidently agreed with him)—having been 64 years a happy witness to the effects of the blessing which he had been instrumental in conferring on his country.

The potato appears to have been taken into favour much earlier in England, as appears from a report of a meeting of the Ray Society, held March 18th, 1662, when a letter was read from Mr. Buckland, a Somersetshire gentleman, recommending the planting of potatoes. This was referred to a committee, who reported favourably, and Mr. Buckland received the thanks of the Society. From this time the field culture of the potato commenced and rapidly extended as its excellent qualities became more known. A strange objection was made by the Puritans, who denied the lawfulness of eating potatoes because the plant was not mentioned in the Bible! Whether or no, a plant so nutritious, and whose culture is adapted to almost every soil and climate, must be regarded as amongst the choicest gifts of Providence. Our countrymen have since done ample justice to this plant, for now, wherever the Englishman seeks a home, he always strives to naturalize the potato plant, and, even when surrounded by the luxuries of tropical lands, remembers the simple vegetable which was so long struggling into notice in his own country.

The Parsnip (*Pastinaca sativa*, L.).—This plant belongs to the natural order Umbelliferæ, and is closely related to the carrot, celery, and parsley, which belong to the same natural order. It is a native of Britain, and of different parts of Europe, and is usually most plentiful on dry banks or on a chalky soil. It is difficult to say whether it is to cultivation or importation that we are indebted for this root. Most likely the former, as it is undeniable that the wild plant, grown for two or three years in rich garden soil, acquires all the characters of the cultivated form, and that when the garden plant escapes into uncultivated ground, it speedily reverts back to its originally wild and degenerate condition. Parsnips appear to have been very early reclaimed from a wild state, for Pliny tells us that parsnips were cultivated on the banks of the Rhine, and were brought from thence to supply the tables of the Roman emperors.

The stem of the parsnip is herbaceous, upright, and furrowed; the leaves pinnate, sheathing the stem at the base, and composed of oval, slightly lobed and incised leaflets. The flowers are small, yellow, and disposed in umbels, the fruit dividing into two seed-like pieces, as is usual with umbelliferous plants. The root of the wild plant is spindle-shaped, sweet and mucilaginous, but nevertheless somewhat woody, and with a slight degree of acrimony which it loses by cultivation. In the wild plant the leaves are downy, but when cultivated they become smooth.

The parsnip is one of the hardiest plants of the kitchen garden, as it remains uninjured in the severest weather; indeed, by many, the parsnip is not esteemed until it has been frost-bitten. There is generally a great consumption of parsnips in Catholic countries along with the salt-fish eaten during Lent.

The Carrot (*Daucus carota*, L.).—The wild form of this plant is found plentifully in Europe and in Great Britain, where it is indigenous, and in the United States, where it has been extensively naturalized. Although the large root is wanting in the wild variety, yet there is little else to distinguish it from the cultivated species, for the leaves, flowers, and even the fruit of the wild carrot are exactly similar to that of the cultivated plant.

The carrot is a biennial, with a stem rising to a height of two feet, leaves compound pinnatifid, flowers white, succeeded by rough hispid seed-vessels, the supporting stalks of which are inflected inwardly, so that the cluster of compact umbels does not look unlike a bird's nest. The root of the wild plant is white, dry, woody, and strongly flavoured. Cultivated, the root becomes succulent, and of a red-yellow or pale straw colour, showing, in a remarkable way, the improvement which may be effected by cultivation.

The carrot was cultivated at a very early epoch even by the Greeks and Romans. The cultivated garden variety has been most probably derived from the wild form. It is difficult to say how its nutritive character was discovered. We know, however, by the experiments of M. Vilmorin, that the wild carrot sown in good land becomes similar to the cultivated species at the end of some generations; and, inversely, that the cultivated carrot returns to the wild form, if planted in bad land, in the course of a few generations.

The Celery (*Apium graveolens*, L.).—This plant is a hardy biennial, indigenous to Great Britain and different parts of Europe; it has even been found by Hooker in the southern hemisphere, and by Nuttall, in California. Wild celery grows by the side of ditches, near the sea, where the water is brackish. Radical leaves, on channelled petioles, green or purplish, stem leaves, ternate, on short petioles, flowers in umbels, axillary, and greenish white. The wild plant is rank, coarse, and suspicious in its appearance, but cultivation transforms it into one of the sweetest and most wholesome of our esculents.

Celery is grown in trenches, and as the plants grow their stems are covered with earth; the light is thus excluded, the stems are blanched or turn white, and are thus rendered edible. Celery appears to have been first cultivated in Italy, for the word itself is of Italian origin, it having been formerly called Ache in England, which is, in fact, its true English name.

There is in the natural order Umbelliferæ two active principles, the narcotic and the aromatic; the former develops itself when these plants are found in moist grounds, and renders them poisonous; the latter principle predominates when the Umbelliferæ grow in dry ground. This may help to cause the difference between wild and cultivated celery, which always grows best in a rich well-drained soil. The process of blanching also doubtless assists in rendering the poison peculiar to the wild plant inert, as the active principles of the leaves of plants are rarely developed when they are deprived of the light.

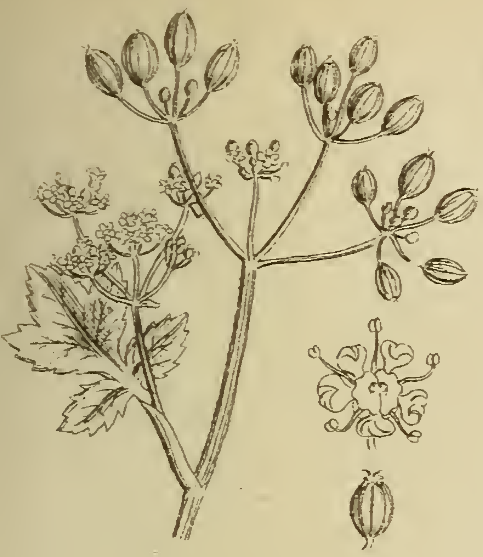
The Parsley (*Petroselinum sativum*).—The parsley is so well known, that a description of it is perfectly unnecessary. It is a hardy biennial, a native of Sardinia, and was introduced into England in 1548. It has naturalized itself in some parts of England on old walls and rocks, usually near the sea. It was used by the Romans as a pot herb, and was also known to the Greeks. The curled variety of parsley is most common in the gardens, and is the safest to cultivate, as from the beautiful curl of its foliage it cannot be mistaken for the poisonous fool's parsley (*Œthusa cynapium*, L.).

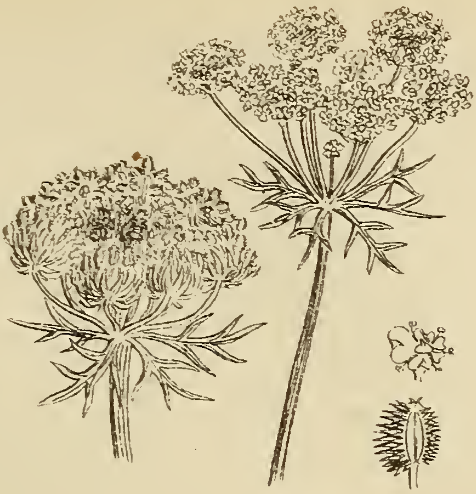
The Cabbage (*Brassica oleracea*, L.).—This plant belongs to the natural order Cruciferæ (*crux*, a cross; *fero*, to bear), in allusion to the petals of the flowers, which are four in number, and arranged in the form of a Maltese cross. The horseradish, cress, mustard, and the different variety of cabbage and turnip all belong to the same natural order. This plant grows wild on European sea-shores, and various places on the English coast—for instance, at Dover and Penzance, where the shores are rocky. The leaves of the wild cabbage are lyrate, glaucous, wavy, the plant occasionally growing from one to two feet in height; the flowers light yellow; pods erect. In spring the sea-cabbage may be gathered and eaten. It was no doubt resorted to as food by the early inhabitants of Great Britain long before any attempt was made at cultivation. The Latin word *Brassica* is derived from the Celtic *Bresic.* There is no plant which has produced, by cultivation, a greater number of varieties than the *Brassica oleracea.* The opinion is generally entertained by botanists, that the white and red cabbage, savoy, borecoles, cauliflower, and brocoli, have all originally sprung from the wild cabbage of the sea-coasts. Now when varieties reproduce themselves permanently, they become races, and there is evidence that some of these races have been cultivated in other countries from the earliest times of which we have any record. Take for example the permanent variety of the red cabbage (*Brassica oleracea* var. *rubra*), now chiefly used for pickling, which was known to the Romans. As the primitive inhabitants of the different European nations had very little communication with each other, it is probable that the wild cabbage (*Brassica oleracea*), which grows on the shores of Denmark, France, and the Mediterranean, furnished, in every instance, the cultivated varieties of those countries. The cabbage was most likely first grown in Great Britain by the Saxons. It was such a favourite with them, that they called the second month of the year *Sprout-kale.*

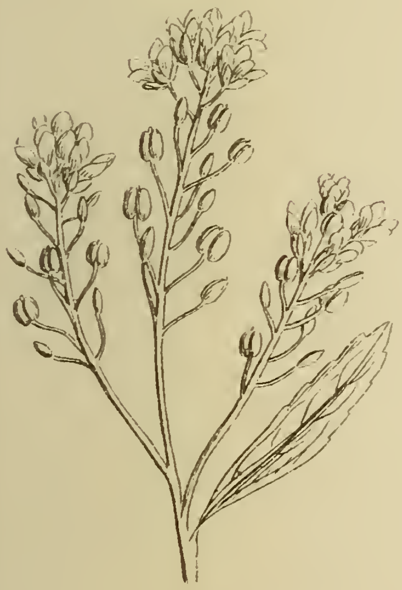
Two leading sub-divisions may be effected of nearly all the varieties of the garden cabbage. These varieties are *either*—1. Headless cabbages, (*Brassica oleracia* var. *acephala*), such as the borecole, the leaves of which continue expanded, never forming a head; or, 2. Close-headed cabbages (*B. O.* var. *capitata*), such as the white and red cabbage and the savoy, whose concave leaves are densely imbricated over each other, and form a close compact head before flowering. The word cabbage is in fact derived from the Latin *caput,* a head, through the French *cabus.* Brussels sprouts (*B. O.* var *subanda*). This is only a variety of the savoy, with an elongated stem, from the sides of which spring out small green heads like cabbages in miniature. If the stem be examined, these sprouts will be found invariably to start just above the scars left by the fallen outer leaves. The cauliflower (*B. O. cauliflora*). In the cauliflower we eat the fleshy flower, stalks, and undeveloped buds, which are crowded together into a compact mass. It was a favourite saying of the great lexicographer, Dr. Johnson—"Of all the flowers of the garden, I like the cauliflower the best!" a sentiment worthy of that learned epicure. The cauliflower was first brought from the Isle of Cyprus, about the beginning of the seventeenth century. *Brocoli.* The name is Italian. This is only a sub-variety of the cauliflower, distinguished from it by the dark green or purple colour of the head. It is also a much hardier plant, and stands the winter.

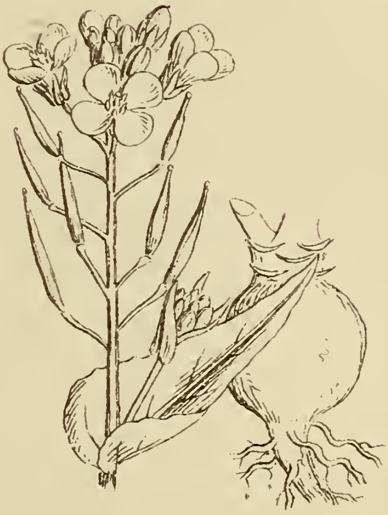
These varieties of the cabbage illustrate in the most striking manner the changes which are produced in species by culti-

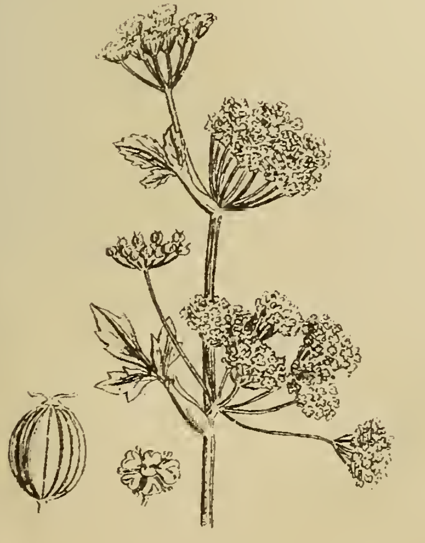
Plate IX.

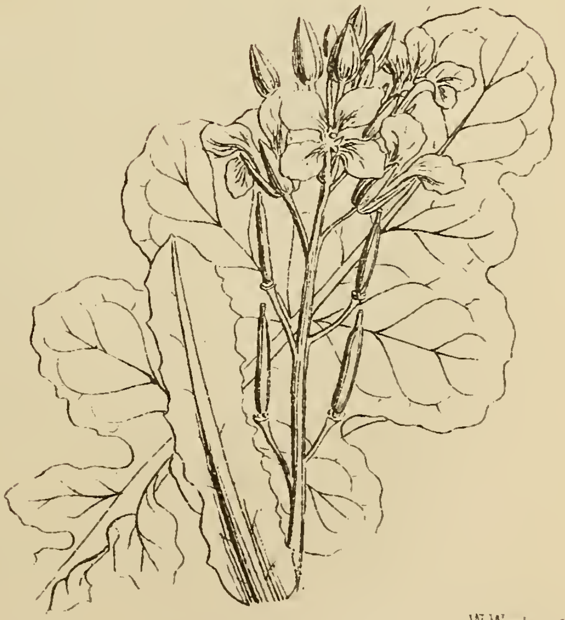

Wild Parsnip.


Wild Carrot


Horse Radish


Wild Turnip.


Wild Celery


Wild Cabbage

Sowerby sc.

W. West imp.

Origin of our Kitchen Garden Plants.

BRITISH MUSEUM
NATURAL HISTORY

vation, and the permanence of some varieties or races. They also give us instructive lessons in the economy of vegetable life.

The Turnip (*Brassica campestris*).—This plant is found wild in many parts of England, by the sides of rivers, ditches, and marshes, but is probably only an introduced plant. It grows spontaneously all over Europe, from the Baltic to the Caucasus. The wild form has hispid, lyrate root-leaves, those of the stem are smooth amplexicaule or stem-clasping. The flowers are yellow; the pod cylindric. The turnip, like the cabbage, has produced several varieties, the result of long cultivation, as for example the common cultivated species of turnip (*B. C.* var. *rapa*, L.), and the Swedish turnip (*B. C.* var. *Rutabaga*), the root of which is yellowish and sub-globose. This last variety, which is the most valuable to the British farmer, has long been grown in Sweden and Germany, and was probably known to the ancients. It was first cultivated in England in 1781, having been brought over originally from Gottenberg. Besides these there is another valuable variety (*B. C.* var. *oleifera*, D. C.), which is largely cultivated in France and other European countries for the oil contained in its seeds, which, under the name of Colza oil, is used for lamps, giving a very brilliant light. The idea of cultivating these plants for the oil contained in their seeds could only originate in those countries where the olive was not introduced or yielded uncertain crops. Colza oil has been used for more than two centuries in the north of France, and its use probably dates back to a still more ancient period. The Greeks and Romans, the Celts and Germans cultivated the turnip; its original country is doubtful on account of the facility with which it becomes naturalized outside of cultivated ground. M. Fries says that *Brassica campestris* and *Brassica rapa* grow spontaneously in the Scandinavian peninsula, and within the last few years the explorations of the French naturalist, M. Ledebow, in northern and eastern Europe, have shown that both these plants are spontaneous through the whole of Russia and Siberia.

The Horseradish (*Cochlearia Armoracea*, G.).—This is the last of the crucifers whose natural history we shall discuss. It is cultivated for its root, the merits of which are well-known in connection with the "Roast Beef of Old England." We shall not occupy the time of our readers with a botanical description of this well-known plant, the cultivation of which is of undoubted antiquity, as it was used in the time of Pliny, the Roman historian. When planted in gardens it is very difficult to eradicate, as the rhizome is furnished with many eyes, each of which will give rise to a new plant. The horseradish is very frequently found growing outside of cultivated ground, on the banks of rivers, and in most situations, but it is very doubtful whether it is indigenous in England. It is, however, a native of many parts of Europe. The root owes its qualities to the presence of a volatile oil which is dissipated by drying. There is no difference between the wild and cultivated plant, except that the root of the former is smaller and more stringy if it happens to grow in a poor soil; but if the soil should be moist and rich in which it is found, then the root of the wild plant is equally good.

We would recommend our readers, if they have leisure, to prosecute this inquiry, as it will be found most interesting in connection with the early periods of human history. It is also an important inquiry, because it has a direct bearing on those formidable questions as to the "Origin of Species," as to the amount of variability of which species are susceptible, and the causes by which that variability is produced; and lastly, as to the geological epoch at which existing species were first introduced, questions which the best naturalists find it so difficult to answer, and which will only be understood when natural history is much more advanced, and the links discovered which unite the present plant forms with those which have preceded them.

We have historical evidence that existing species have not varied for several thousand years, and the reason is plain enough, because the external circumstances in which they have been placed have not varied. For all practical purposes, therefore, the characters on which species are found may be assumed to be constant; and a minute and careful description of a plant will suffice, not only for the present, but for many succeeding generations of naturalists. But we have no warrant from nature to assume that such specific, or even generic, characteristics either have, or will continue to be, permanent for an unlimited period of time, that they will survive all future changes in the physicial geography of the planetary surface. We know that great changes may be effected in a brief space of time in the organization of plants by cultivation; and why should not an organic change be brought about in plants when their external circumstances are altered by nature in the course of ages? This world, what is it but a great and ancient theatre where the scenery of life is ever changing? Look at that majestic and venerable tree; its present form appears to be fixed, yet that very form is in reality as fleeting and evanescent as all the other forms through which that tree has passed from its first life movement in the seed; and what is true of that tree, which is a part of nature, is true of the whole of nature, the present appearance of nature now is no more unalterable than at any other geological epoch. It is the last of the many phases of creation, and equally fleeting with all the others.

THE GEOLOGY OF MINERAL SPRINGS.

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IT is a favourite subject of speculation with many persons, who are rather disposed to occupy themselves with the ideal than the practical side of life, to seek compensation for the imperfections and drawbacks inherent to things *as they are*, by imagining them *as they might have been*. Any of our readers who may have a disposition in this direction, and who, at the same time, may be liable to an occasional fit of unphilosophical irritation from these periodical irregularities of water-supply, which are by no means infrequent, even under the auspices of the best-regulated water companies, may possibly derive some consolation under their grievances from the contemplation of the condition in which they might have found themselves when they were thirsty if the geological conformation of the earth had been otherwise arranged than it is. Should they, moreover, indulge at times in the habit of forsaking the stream which springs spontaneously in their own back yard for the meretricious attractions of Homburg, Kissingen, Schwalbach, or any of the other localities whose healing waters are periodically troubled for the benefit of the valetudinarian crowd who frequent them, they may, perhaps, feel an additional incentive to investigate, in a cursory manner, the causes to which they owe alike these health-giving fountains and their humbler rival, the domestic pump.

At the present time, when the schoolmaster has got so far "abroad" that one begins to wonder whether he will ever find his way home again, every one is sufficiently familiar with the elementary facts of geology to be aware that the earth's crust is composed, in a great measure, of a series of strata, lying over one another like the coats of an onion, which have been formed by the successive depositions of sedimentary matter that have taken place in the seas and lakes of former ages. But, from the habit which geological diagram-makers have of representing these strata, generally as superimposed horizontally upon another, many people are not aware, or, if aware, are sometimes apt to forget, that although theoretically, and on the large scale, this method of representation gives a correct idea of the relations which the strata bear to each other, practically their original horizontal position has in most cases been so disturbed by the projection through them of those masses of igneous rock, of which the backbone of the earth's hills and mountains is composed, that the surface of the ground itself and the strata beneath it have been tilted up and contorted in every possible direction. A very little consideration will show that such an arrangement as this is eminently favourable, not only to the drainage of the surface of the land from those accumulations of water with which heavy and continuous rains would otherwise soon cover it, but also to that system of subterranean drainage by which the water that sinks below the surface is collected into a series of channels, by which it is conducted into its great reservoir—the ocean. But this irregularity of stratification serves other ends than the mere facilitation of drainage. From the tendency which all strata have, in consequence of their occasional angular elevation, to "crop out," as it is technically called, at different portions of the earth's surface, the rain which falls upon the ground has an opportunity of penetrating those deeper strata which would otherwise be protected by the impermeable ones that lie above them; and thus all the more soluble portions of the earth's crust are, to a great extent, wasted alike, and each contributes its share to those new beds of sediment, which now, as in times past, are continually forming beneath the waters of the ocean.

But now let us suppose that instead of this state of things the various strata had been undisturbed in their primitive arrangement, and had continued horizontal in their position throughout; that the surface of the earth was unbroken by mountains or valleys; and that its seas and lakes were merely excavations in it, like so many holes cut into a pile of thin bread-and-butter. What would have been the result in a hydrographical point of view? Amongst other things it is very clear that the rain which fell on the ground would have had to remain there until it soaked away downward instead of running off into a series of definite channels as it does now on all surfaces that are at all inclined. Having, however, made its way down for a certain distance through the porous coating of mould, sand, gravel, &c., which forms the superficial covering of the earth in most parts, it would, ere long, have been arrested in its course by the first impervious stratum at which it arrived, and there it would have accumulated until it acquired sufficient pressure to ooze out in all directions into the sea. There would have been no rivers, for there would have been neither the physical elevations nor the conditions of unequal solubility* of strata upon which the formation of rivers depends. Every stratum beneath the first impermeable one would have remained intact, and the great law of the equality of waste, in virtue of which every formation contributes its share to the re-arrangement of land and water, which is perpetually going on would have had no existence. Of course there would have been no springs, for as there would have been no mountains or hills through which the water could percolate to lower levels and rise up again through the first fissure which it meets, as it does now, it would have stood at a dead level everywhere. In fact, the earth would have been one vast swamp, covered, possibly, by a luxuriant vegetation, but totally unfitted for the habitation of man. Such was, in all probability, its state in those long-passed epochs, whose relics have come down to us in the carboniferous, oolitic, and other early formations.

From these considerations it will be evident that both the abundance and the peculiar character of the springs in any given locality, will be entirely dependent on the geological conditions which prevail there. For instance, their eruptive energy, that is, the force with which they rise, or the height above the surface of the ground to which they are projected, will be determined by the existence in the neighbourhood of elevations which, by the fall that the water percolating through them acquires, will enable it, by the well-known law which governs fluid equilibrium, to rise to a level corresponding to that from which it has descended. This is well shown in the fourth of our illustrations, where *c* represents an elevated tract of country, immediately beneath which the porous stratum *b* crops up on the surface. The rain-fall of the land above *c* will gradually percolate through this stratum until it either makes its way up a natural fissure, or an artificial boring at *e*, where it will form a vigorous spring, or spontaneously exudes as a weak one at the other outcrop of the stratum at *d*.

But it is as much to the character as to the inclination of the strata of a district that the distribution of its springs is due, and more particularly to the mutual relations of the porous and impermeable formations which it contains. The proportion which the former of these bear to the latter is, in the majority of cases, very small. When we remember that it is only sand, marl, gravel, and other similar loose materials which allow of the percolation of water, and that the great bulk of the sedimentary formations, and all the unstratified ones, are nearly, if not quite, impervious to it, we shall have no difficulty in understanding the obstacles which they present to the penetration of water for any depth into the earth. In the illustration to which reference has already been made, we have the most favourable condition for subterranean drainage that can occur, viz.: a porous stratum overlying and overlaid by impermeable ones, as, for instance, the Lower Green Sand lies between the Gault and the Wealden Clay. The rain below that portion of the hill (*c*) where the Lower Green Sand crops up will not penetrate below the layer of alluvial soil, by which the earth is thinly covered, but will gradually make its way down the incline to the level of the valley at *e*, where it will form a lake or river, as the case may be. This is shown still better in the second illustration, which represents a section of a hill formed of unstratified rock, covered with a thin coating of soil. The rain-fall on such a hill will gradually soak down its sides to appear as a spring at Q on the right; or, if a portion of the surface has been denuded, as a stream, at Q on the left. But it does not follow because the strata of a given formation are, in the main, composed of a rock that is itself impermeable that they are therefore incapable of drainage. It is quite possible for water, under such circumstances, to find its way through the seams which separate the different members of such a formation, and which are often filled with sand or some other porous material. By referring to the third of our illustrations we shall not only see how this may occur, but also how it may affect the hydrographical features of a locality. Here we have a hill formed of stratified rock, which has been so disturbed as to give it a dip to one side. The rain which falls on the left side of the hill will find its way downwards through the seams of stratification until it meets with the drainage of the other side, which, in consequence of the peculiar direction of the stratification, will be confined to the surface, and the two will give rise to a stream or spring at Q. We have a further proof of the influence of geological disturbances on the water supply of a district in the first of our illustrations, which represents a valley (T), which has been formed by the disruption of a stratified rock (*a*) in consequence of the projection through it of a mass of volcanic rock. It will be seen that owing to the dip of the strata on either side being outwards, the rain which falls on the sides of the valley will drain off to the opposite side, where it will form streams or springs at Q, whilst the valley itself will be destitute of such features.

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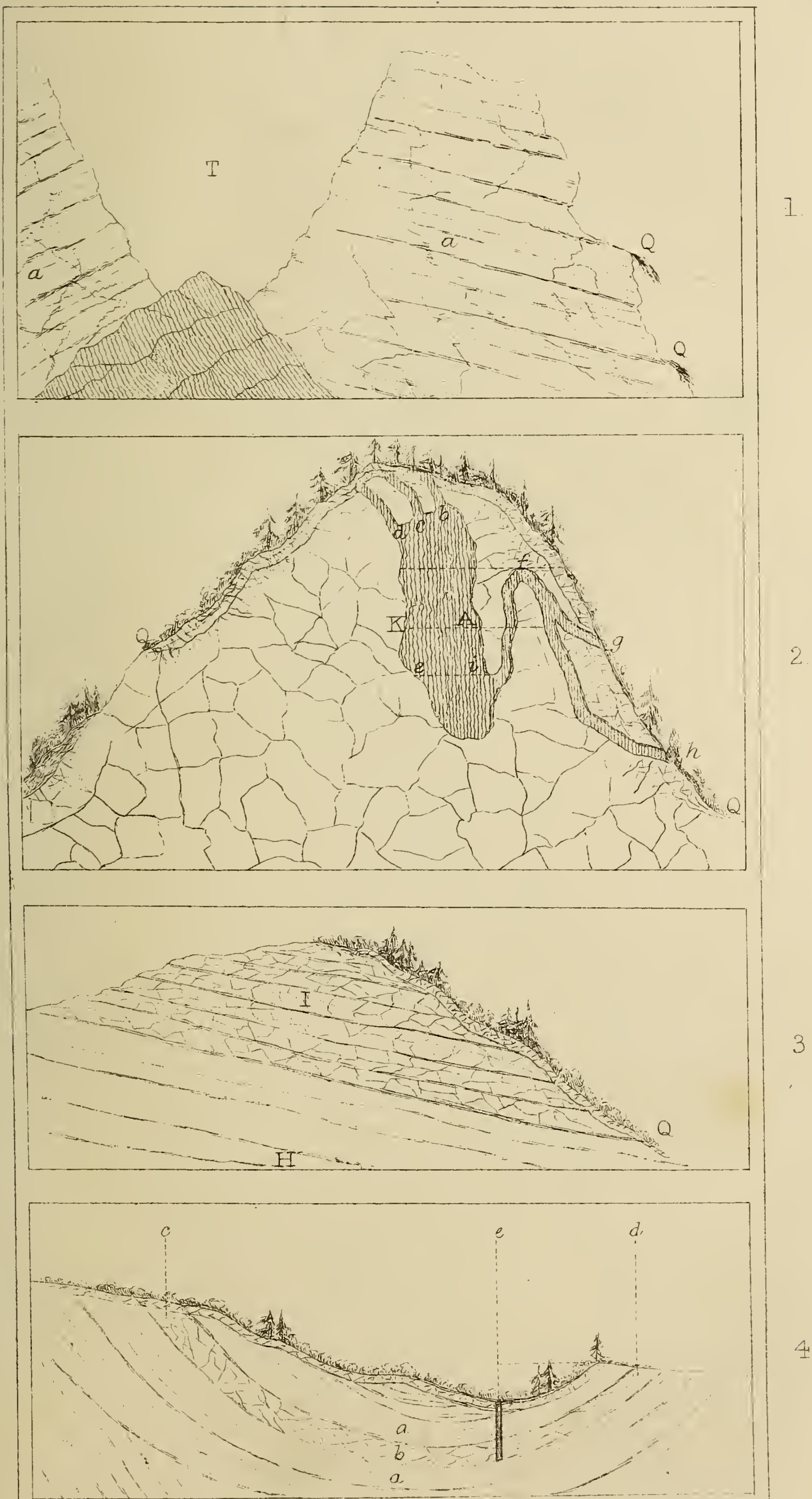
* By the term *solubility* here is meant not so much chemical solution as mechanical disintegration.

It often happens that where the superficial drainage of a district is insufficient to provide a water supply equal to the local demands, an attempt is made to reach the reservoirs of water which are supposed to exist in the strata at a considerable depth below the surface, by boring into them until water appears. Wells formed on this principle are called Artesian, from their having been supposed, at one time, to have been first made in the province of Artois, in France; but, like many other modern inventions, they are really of very high antiquity, having been known thousands of years ago both to the Chinese and Egyptians. At the present day the country immediately around Thebes contains the remains of numerous Artesian borings which were probably made to supply that city with water. As an Artesian well is only an artificial spring, a brief account of the conditions which are favourable for making one will not be out of place here, especially as they are exactly those which govern the formation of natural springs. In making such a well the first step taken is to excavate an ordinary well to a sufficient depth to serve as a reservoir, in which the water of the Artesian spring may accumulate. From the bottom of this a bore is driven by means of an auger adapted to the purpose, worked by horse or steam power, and which is carried down until water is reached. Although at first the progress made in boring is pretty rapid, when a considerable depth is attained it becomes very slow in consequence of the frequent necessity of drawing up the boring rods to cleanse the borer of the débris which accumulates in it, and of the great caution which is requisite to avoid breaking it. At a depth of about 1000 feet the progress made does not exceed three feet a week under the most favourable circumstances. As water exists at considerable depths under great pressure, it follows that when reached by the bore it sometimes rises up it with much force; indeed, it is upon this great subterranean pressure that the possibility of forming an Artesian well at all depends. The cost of making such a well is always great, and sometimes enormous. Upwards of £19,000 was expended upon one that was attempted some years ago with the view of providing the town of Southampton with water. The experience which was gained by this and some other cases of costly failure has attracted more attention to the conditions which are necessary for the success of such an undertaking than had been previously given to them, and the subject is now pretty well understood. These conditions are (1) the existence of a porous stratum having a sufficient outcrop on the surface to collect an adequate amount of rainfall, and passing down between two impermeable strata; (2) the level of the outcropping portion of the porous stratum must be above that of the orifice of the well, so as to give a sufficient rise to the water; (3) there must be no outlet in the porous stratum by which its drainage can leak out, either in the shape of a dislocation, by which it can pass into lower strata, or a natural vent, by which it can rise to the surface at a lower level than the well. The importance of all these conditions being present can hardly be better illustrated than by a reference to the unsuccessful experiment of the well on the Southampton Common, alluded to above. The permeable stratum upon whose water supply reliance was placed was the Upper Green Sand, lying between the Chalk Marl, and the Gault, both of them impervious to water. Although the outcrop of this formation is not large, being confined to the margin of the irregularly shaped oval basin which the chalk forms in this district, it was considered sufficient to supply the wants of the town; and if by any unforeseen contingency this stratum should fail to yield a sufficient water supply, there lies below it the Lower Green Sand, which has a more extensive outcrop still. The conditions of elevation were considered equally satisfactory. The mean level of the outcrop of the Upper Green Sand is about 300 feet above that of the mouth of the well, so that if no natural vent for the water in it existed at a lower level than the well, it must rise in it to the surface. These facts having been determined upon reliable geologic data, and there being no positive evidence of any break in the strata by which the waters of the Upper Green Sand could pass into lower strata, operations were commenced, and carried on until a depth of 1,313 feet was reached, and an outlay, as has been stated before, of upwards of £19,000 expended. But, to the surprise of every one, not even the *Upper* Green Sand had been arrived at; the bore, after traversing 848 feet of the chalk, was still in that formation, and from a comparison of data it was probable that from 20 to 50 feet more of the chalk would have to be perforated before the Upper Green Sand was tapped. Then the question began to be discussed, supposing that the Upper Green Sand were reached, was it certain that it would contain a sufficient supply of water, or any water at all? In the attempt to bore an Artesian well at Calais both the Upper and Lower Green Sand were passed through without any water being found. In that of St. Grenelle, at Paris, the supply came from the Lower Green Sand only. It was known that there was a fault or irregularity in the chalk in the neighbourhood of Winchester, and it was just possible that this might so far have disturbed the Upper Green Sand as to allow its waters to pass into the strata below. Should this be the case the boring would have to be carried probably 250 feet lower down, at an additional cost of £3,000. Nor did it follow that when the Lower Green Sand was reached and found to contain water that the water would rise to any height in the boring, for it might have a natural vent at a level lower than the mouth of the well, such, for instance, as would be provided by the termination of that

Plate X.



W. West lith^{r}

Mineral Springs

BRITISH MUSEUM

formation in the sea, at the back of the Isle of Wight. But the unfavourable hypotheses were still unexhausted. Even if water were obtained at this depth, it was open to doubt whether it would be fit for domestic use. That obtained from an Artesian bore, which had been made at Chichester and carried down to a depth of 1,054 feet, was so strongly impregnated with carburetted hydrogen as to be repulsive both to taste and smell. Or it might be saturated with sulphuretted hydrogen, which was, if anything, worse. Under any circumstances it was certain, if the evidence, not only of natural springs, but of other Artesian borings, was to be relied on, that its temperature would be high, probably as high as 80° F., possibly much higher. Now water at 80° may be very pleasant to wash with in winter, and may be adapted for boiling, but it is decidedly unfit, not only by its temperature, but from its want of air, for drinking, and before it could be used would require to be both cooled and aërated, which would involve additional cost. Under these circumstances, and notwithstanding the advice of the late Dr. Buckland and other eminent authorities, who, at the meeting of the British Association in the town in 1846, encouraged the prosecution of the work, it is not to be wondered at that the corporation of Southampton began to halt in the enterprise, and ultimately determined to stop boring at once and to look for water elsewhere. The well was, therefore, closed up, and a heap of stones, a solitary sapling, *and the interest of the money expended,* are the only relics left to record the fate of one of the most costly and interesting experiments in well-making ever perpetrated.

It has been before observed that Artesian wells can only be successfully bored where porous strata are intercalated between impermeable ones. Where the intercalation is often repeated, several distinct sources of water may supply a single well. In that at Bruck, near Erlangen, there are three such sources; in that at Dieppe, seven; whilst the well at Dulmen, in Westphalia, is supplied by no less than thirteen strata, in a depth of 380 feet. The great distance from which the water of an Artesian well may be derived, was well shown by a boring near Tours, from which, when the borer was withdrawn, quantities of sand and small snail-shells were ejected, which must, without doubt, have found their way there from the mountains of Auvergne, 30 miles distant. A curious proof of the occasional direct communication of Artesian borings with superficial accumulations of water was given by wells of this description at Bochum in Westphalia, and Elbœuf in France, in the water from both of which eels and small fish have at times been found.

Amongst the unfavourable conditions for the prosecution of the Southampton well, was mentioned the possible drainage of the waters of the Green Sand into the sea. Not only is the termination of a porous stratum in the sea common enough, but it sometimes occurs under such circumstances as to give rise to the singular phenomenon of fresh, or even mineral springs, rising in the sea, and preserving their identity for some distance from their place of origin. Such a spring is mentioned by Humboldt as occurring at the mouth of the Rio Lagartos, off Cape Caloche, 400 yards from land. Another is quoted by Spallanzani as existing in the sea off Spezzia, and troubling the waters to such an extent that a boat, when over it, is violently agitated. Between Castellamare and Sorento there is a sulphuretted spring in the sea; and the inhabitants of Syracuse enjoy the paradox of supplying themselves with fresh water from a spring which rises in the sea near their town.

All springs may be divided into *cold* and *warm*, or, as they are often called, *thermal;* and this division bears an intimate relation to their geological origin, for the deeper the source of the spring, the higher is its temperature. Taking the mean annual temperature of the air as the standard of comparison, it has been found that the majority of springs are *thermal, i.e.*, their temperature is above the mean of the air of the locality above them. The cause of this elevation of temperature is easily explained. It is a fact well established by a large number of observations, that the temperature of the earth increases the further we descend below its surface. The only exception to this law occurs in tropical countries, and in temperate ones during the heat of summer. In both of these cases the superficial portion of the earth's crust is heated by the solar rays; but as their influence gradually diminishes in proportion to the depth we descend into the ground, we soon reach a point where it ceases altogether. This point varies in depth in different parts of the globe, according to the degree of latitude, and its extension over the globe forms what is called the *surface of constant temperature.* The exceptional decrease of temperature which takes place from this cause is shown in a well at Bahia, 200 feet deep, the temperature of the water in which is only 68° F., whilst that of the surface of the ground is 81° F. But although it is an undoubted fact that there is a gradual rise of temperature as we descend into the earth, the *rate* of increase is by no means uniform. It is, indeed, stated in most text-books that it occurs in the proportion of 1° F. for every fifty feet of descent; but even if this could be reckoned on as the average, the limits of fluctuation are very wide. It was found that in nine Prussian mines the increase varied between 1° F. in 21·3 feet, and in 155·5 feet. In some mines in Saxony, in the granite, the average increase was 1° in 57·3 feet; whilst in one in the tertiary formation in

Tuscany it was 1° F. in 18 feet. It is probable that much of this variation depends upon the varying conducting power, or specific heat of the different formations themselves. Assuming that 1° F. is the average rate of increase for every 50 feet, it is estimated that at a depth of 20 or 30 miles every known substance would be in a state of fusion. Without entering into a discussion of this aspect of the theory of a central heat, against which some very cogent arguments have been urged by Mr. Hopkins and others, we are clearly justified in accepting the fact that so far as our observation carries us, the earth's temperature rises as we descend into it; and it is no unreasonable deduction to infer that it is the source of that warmth which all deep-seated springs possess. The warmest natural springs known are the Geysers, whose temperature, as determined by Bunsen, is 248° F., or 36° above the boiling-point, at the depth of 74 feet in the tube of the Great Geyser. Then come the springs of Aguas Calientes de las Trincheras, between Porto Cabello and New Valencia, in South America, whose temperature is 207° F. From this temperature we may find springs exhibiting every gradation of temperature down to 33° F., or 1° above the freezing-point, which is the constant temperature of a spring at Walberg, in Lapland. The valuable source of heat which thermal springs contain has, in some cases, been utilized for practical purposes. Thus, the small town of Eaux Chaudes in Auvergne, warms the whole of its houses during the winter by the water of its hot springs, whose temperature is 176° F., and which is circulated by pipes. It is very much in keeping with the above-mentioned theory as to the source of the heat of thermal springs, that they are so frequently found in the neighbourhood of active or extinct volcanoes. In the former case we have a ready explanation of the phenomenon in the propinquity and constantly recurring ejection of highly-heated materials, by which the surrounding country must be sensibly warmed. In localities where active volcanic disturbance has long ceased, as in the Eifel district, the high temperature of local springs is probably due to the great depth of the chasms from which they arise. Sir Charles Lyell, in his admirable address before the British Association at Bath, last September, has pointed out another important link between volcanoes and hot springs, in the fact that whilst the latter are known in many regions to be situated along "lines of fault," that is, lines along which the rocks have been rent, the former are also supposed to exist along similar but more extensive lines of dislocation on the earth's surface. But a large number of thermal springs occur not so much in the primary rocks themselves, as in the line of junction between them and other formations. For instance, most of the hot springs of the Pyrenees exist in districts where the granite comes in contact with the cretaceous formation; those, too, of Marienbad rise at the point of junction between the granite and transition strata. It is easy to understand that the point of junction between primary and sedimentary strata should be favourable to the emission of springs, from the fissures which are likely to exist there, in consequence either of the decomposing influence of the eruptive on the sedimentary rock, or from the contraction produced by the cooling of the former. It has been suggested that the origin of metallic veins, which generally occur in the same situation, may have been due in past ages to hot springs charged with the constituents of these veins, which have gradually deposited them in the fissures through which they were emitted. Before leaving the subject of the temperature of springs, it should be mentioned that some authorities, and amongst them more particularly Dr. Volger,* maintain strongly that all the phenomena of thermal springs are explicable without any necessity of invoking the hypothesis of a central heat, referring them to the combined effects of chemical decomposition, pressure, and motion.

There is one feature of many springs which deserves a passing notice, and that is, the phenomenon of intermission. The intermission may be either partial or complete. In the former case the spring only diminishes in activity at certain periods; in the latter, it ceases altogether at times. The period of intermission varies greatly in different springs. That of Poterbrunnen, at Paderborn, in Westphalia, ceases for 6 hours, and then flows again for 6 hours more with such energy as to turn three mills. Another spring at Pontarlier, in the Jura, intermits every 6 minutes. Another at Fontestan, near Mirepoix, flows for 36½ minutes, and then ceases for 33½ minutes. Another at Colmar, in Prussia, flows twice in the 24 hours, for 7 hours each time, and ceases twice for 5 hours. We have two intermittent springs in England,—that at Giggleswick, near Settle, in Yorkshire, and Tideswell, in Derbyshire. Both of them flow for a few minutes only, and both rise in the mountain limestone. But the most interesting case of intermission is that of the well-known springs of the Geysers, in Iceland, before alluded to, the smallest of which flows for 15 to 20 minutes every 2 hours, and the largest only once in 24 to 30 hours. These intermittent ejections are probably caused by the irregular ebullition of the water in the pipe of the Geysers, giving off masses of vapour at intervals, which carry water up with them into the air, just as in the case of the convulsive ebullition which takes place in a deep and narrow test-tube. The intermittence of other springs is due to other causes. Sometimes it is produced by the irregular evolution of carbonic acid gas in the waters of the spring, as in those of Nauheim, Kissingen, and Carlsbad; at others it is owing to a connection existing between the spring-bearing strata and the sea. At the flood-tide, the pressure exerted by the sea upon the water in the strata presents an obstacle to its exit; and hence it rises in the springs, whose flow is increased at these periods. At the ebb this state of things is reversed. Such intermittent springs exist at Skogapordar, in Iceland; at Noyell, in the department of the Saône; and in Artesian wells at Dieppe and Fulham. Another variety of intermittent spring is exhibited in our second illustration, where we have a cavity A in the substance of a mountain, into which water finds its way by the three orifices *b*, *c*, *d*, and from which it passes by a siphon, which may have its outlet either at *g* or *h*. As soon as the water has accumulated in the cavity as high as the level of *f*, it will begin suddenly to flow by either *g* or *h*, in consequence of the well-known property of a siphon; but directly it has sunk to the level K, the flow from *g* will cease: and when it has fallen below *ei*, that from *h* will also discontinue. No flow will occur again from either outlet until the water has reaccumulated to the level of *f*, when the same order of events will be repeated.

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* "Erde und Ewigkeit." Frankfurt a. M. 1857.

As we have already exceeded the limits of the space allotted to us, we have no room left to speak of the chemical constituents of mineral springs, a subject which is full of interest, both in a mineralogical and geological point of view.

REVIEWS.

ENTOZOA.*

IT is customary among the members of a certain class of scientific men to underrate everything in the form of literary work produced in this country, and to over-estimate the labours of continental *savans*, especially German ones. This is a state of things very much to be deplored, for it forces those who are in ignorance of the immense progress which science is making in England to imagine that we are behind our continental neighbours, and consequently, it in great measure prevents that support and approbation which, under more favourable conditions, the English people would certainly accord to scientific workers. When we say that this habit prevails in a particular section of the scientific world, we would have our readers to understand, that it is entirely confined to that section, and furthermore, that in our opinion, the tendency to give continental work a higher rank than to that accomplished within our islands, arises from a combination of three causes : want of information ; absence of patriotism ; and a desire to impress those who are unacquainted with continental writings, that the individuals who extol them are perfectly familiar with them.

The best proofs we can offer of the absolute accuracy of our views upon these points, are the number and importance of the truly philosophic treatises which are annually published in Great Britain. Not a month passes by, but we find announcements of valuable original essays on scientific subjects, about to be issued from the press. And where, we ask, upon the Continent, can the like be observed? In no branch of Science more than in that of Biology, do English essays equal, if not exceed, in number and usefulness, those of foreign writers. There are, indeed, certain departments in which we find our home productions do not come quite up to those upon the other side of the English Channel; but let it be also remarked that the gaps are being rapidly filled up, and that the impetus which natural science has of late years received, has stimulated our "working men" to the achievement of much that was wanted. Of late we have been reproached for that we were not keeping pace with foreign naturalists in regard to the investigation of entozoa; and this censure seemed just, when it was borne in mind that the only treatise upon the subject in its entirety, which our language possessed, was a translation of a work written by Herr Küchemeister, more than ten years ago. Happily the time has arrived when such reproaches can no longer be applied. A gentleman whose name is known favourably in every land wherein Entozoology is pursued, and who has already contributed several original memoirs upon the subject of entozoa to our scientific periodicals and "Transactions," has given us a volume, which, from its extent and method, apart from other features, is superior to anything of the kind which has yet been presented to our notice.

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* "Entozoa: an Introduction to the Study of Helminthology, with reference more particularly to the internal Parasites of Man." By T. Spencer Cobbold, M.D., F.R.S., Lecturer on Comparative Anatomy at the Middlesex Hospital. London: Groombridge & Sons. 1864.

Dr. Cobbold's work is an embodiment of all that has yet been done upon the subject of human intestinal worms, and in it we find the results of his own carefully conducted inquiries; judicious and impartial analyses of the conclusions at which all other entozoologists have arrived; an exquisitely executed series of coloured and tinted plates, delineating the more interesting and rare species; numerous truthful woodcuts intercalated with the text; and, finally, in the form of an appendix, a bibliography, extending over *sixty* pages, and embracing the titles (and writers' names) of all papers on entozoa that have been written in English, up to the time of the publication of the volume. This latter character we deem of the utmost import, as, besides furnishing the student with much valuable information, it demonstrates to the general public how unjust and devoid of foundation have been the accusations of those who slander our British naturalists.

To give anything like a fair review of the beautiful volume before us would require an amount of space equivalent, at least, to half of our present number: we shall therefore only indicate a few of the points which we deem especially worthy of consideration. The classification which the author adopts is a new one, or rather a modification of Von Siebold's and Professor Owen's. He includes, with the true entozoa, the turbellaria (which Siebold elevates to the rank of a distinct class), and then calling the entire group Helmintha, he divides it into three sub-classes: *Sterelmintha*, including the orders Turbellaria and Trematoda, and whose comprised species are characterized by the absence of an anal opening and the presence of a digestive cavity which seems hollowed out of the substance of the body, and is usually branched; *Cœlelmintha*, embracing the single order Nematoda, whose members possess an oral and anal aperture, and a true digestive canal; and finally, *Anenterelmintha*, a term partly coined by the author, but which has been used in a somewhat similar form, and exactly similar sense, by Leuckart, Rymer Jones, and others, and which comprises two orders, Acanthocephala and Cestoda, whose species have negative characters, viz., the absence of anal and oral openings. Being desirous of retaining the term Entozoa, as applied to a somewhat kindred series of creatures, we hardly think that the writer could well have adopted any other system than that proposed; but we think he might with advantage have omitted the turbellaria from the scheme, particularly as he includes in this order both Nemertes and Planaria, which can hardly be said to have very decided affinities. Moreover, we do not see upon what grounds the *Sterelmintha* are placed first in the series, as it seems to us that *Cœlelmintha* have paramount claims to the highest rank. But these are matters of very little importance. It is, we consider, questionable whether the digestive or procreative system is more entitled to consideration as the basis of a plan of classification, and hence, as a matter of choice, we cannot object to Dr. Cobbold's selection of the former. But might not the group be divided equally well into two sub-classes, Diœcia and Monœcia; the former including the Acanthocephala only, as being a peculiar tribe, and the latter being divided into three orders; one characterized by the presence of neither mouth nor anus, the other by the presence of a mouth alone, and the third by the existence of both apertures? Indeed, except for convenience, we strongly object to the employment of the expression Entozoa, inasmuch as it seems to us unadvisable to classify animals according to their habitats. It seems as if in the arrangement of the whole series of Annuloida, too little attention has been paid to morphological and physiological characters, and too much to distributional features. The proposal has been made to separate the Trematoda from the rest of the so-called Entozoa, and by uniting to them the leeches and planariæ to form a new order Suctoria, and we hope to see this method eventually adopted.*

It would be quite impossible to deal *seriatim* with the various chapters of Dr. Cobbold's excellent book, in each of which we find ample space devoted to the history, anatomy, development, and habits of the species under description. But we would refer our readers to the chapter on the Trichina, in which will be found full details concerning this singularly interesting parasite, and from which we quote the following conclusions which the writer gives as recorded by Leuckart, who has paid special attention to this species:—

> "(1.) Trichina spiralis is the juvenile condition of a little round worm, hitherto unknown, to which, however, the generic name of Trichina must remain attached. (2.) The sexually mature Trichina inhabits the intestinal canal of numerous warm-blood animals. (3.) The second day after their introduction, the intestinal Trichinæ attain their full sexual maturity. (4.) The eggs of the female Trichina are developed within the uterus of the mother into minute filaria-like embryos, which, from the sixth day, are born without their egg-shell. (5.) The new-born young soon after commence their wanderings. They penetrate the walls of the intestine, and pass directly through the abdominal cavity into the muscle of their bearers. (6.) The directions in which they proceed are in the course of the intermuscular connective tissues. . . . . (15.) The immigration of Trichinæ-brood in masses produces very grave, or even fatal consequences; peritonitis (from the embryos perforating the intestinal walls), pain and paralysis (from the destruction of the infected muscular fibres)."

The chapters on the subject of spurious helminthology should be read by all medical men, for they show that, in many instances, organisms may be found in the excrement of animals (man included), which, to the untrained eye, present the appearance of true entozoa, and yet may either belong to an entirely different group of beings, or may absolutely be portions of undigested food, or may, as in the following instance, be simply introduced into some of the excretions (that of the kidneys for example) to deceive the physician:—

> "In the museum adjoining the Middlesex Hospital we have a Gordius, which was brought to an M.D. (since deceased), who, notwithstanding his eminence as a physician, was induced to believe that the worm in question

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* See on this subject a paper "On the Affinities of the Groups Trematoda, Planariæ, and Hirundinei. By Henry Lawson, M.D., in *The Dublin Quarterly Journal of Science* for 1861.

was a genuine Dracunculus. It is said, moreover, that he paid four guineas for the specimen."

Ere terminating our notice of this work, we must pay our highest tribute of praise to the enterprising publishers, who have issued a volume which, as concerns its mechanical features—type, paper, illustrations, &c.,—reflects the highest credit upon those connected with its production. Of its value as an addition to science-literature we have already spoken. In conclusion, however, we would observe that it is a treatise which every naturalist must possess, and without which no medical man's library can be considered complete.

BRITISH SPONGES.*

WE had begun to fear that the Ray Society would in future devote itself to the production of essays on the animals of distant countries. We had almost anticipated seeing some ponderous volumes upon the zoology of the Sahara and the flora of the Punjaub ; but we are glad to perceive that our fears were groundless. This useful institution has again returned to its proper field, and has given us a most excellent treatise upon the sponges of Great Britain. When we state that this volume has been written for the society by Dr. Bowerbank, naturalists will readily admit that few could have been selected more worthy of the task than the gentleman who has spent, we may say, a lifetime in the investigation of our native *Porifera.*

The book which has just been issued constitutes only one volume of the entire work; but since it deals with the anatomy and physiology of the sponge, it is, of course, of paramount importance. The subject has been very carefully handled by the author, and the result is the production of a mass of information which can only be had elsewhere after a prolonged examination of the English and Continental periodicals of the past fifteen years. A sponge may be said to consist of a mass of *sarcode,* supported upon a network or skeleton of a more solid substance, and having two classes of apertures in its external surface, which communicate with as many distinct varieties of canals. The skeleton is in some instances composed of an interlacement of fibres, which are made up of some organic material ; in others it is constituted of hard, unyielding prickles or *spicules,* as they are technically termed. These spicules are so arranged upon one another, that while supporting the sarcode mass they leave several anastomosing spaces which form the canals ; and finally they may be either calcareous or siliceous in composition. These characters of the spicules determine the division of the sponge class into three orders—the *Keratosa* (horny ?), *Silicea* (flinty), and *Calcarea* (limey). This arrangement is in some measure a modification of Professor Grant's, and though no doubt a very convenient one, is to our mind objectionable because somewhat artificial. This objection, however, will not prove serious to the mind of the student, as there can be little doubt that in identifying species, the empirical taxology often with advantage takes the place of the natural one. The apertures of which we have spoken have two very distinct offices; the smaller ones, which are termed *pores*, being for the admission of water (containing air for respiration and food for digestion), which passes into the interior by the canals; and the larger ones, which are termed *oscula*, allowing the used-up water to make its exit from the substance of the animal. Viewing all these characters in their *tout ensemble*, the writer thus defines a sponge :—

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* "A Monograph of the British Spongiadæ." By J. S. BOWERBANK, LL.D., F.R.S., F.L.S. Vol. I. London: Published for the Ray Society by R. Hardwicke. 1864.

> "A fixed, aquatic polymorphic animal, inhaling and imbibing the surrounding element through numerous contractile pores, situate on the external surface, conveying it through internal canals or cavities, and ejecting it through appropriate orifices ; having an internal flexible or inflexible skeleton, composed of either carbonate of lime, silex, or keratode, with or without either of these earthy materials. Calcareous skeletons always spicular ; siliceous skeletons either spicular, or composed of solid, laminated, and continuous siliceous fibre."

The description given of the several different varieties of spiculæ is the most diffuse we have yet seen, and were it not for the immense number of technical terms (there being one for each form of spicule), would prove exceedingly instructive. We would not have it thought that in expressing this opinion we are desirous of censuring the author. We believe there would be considerable difficulty (if, indeed, it were possible at all) in adapting ordinary language to define tersely the anatomical characters of certain organs ; a fact which botanists are well acquainted with. But being ourselves of opinion that the introduction of technicalities, while it does not advance philosophy, tends to trammel the popularization and diffusion of scientific knowledge, we regret to perceive the huge store of these formidable expressions with which the pages of Dr. Bowerbank's work abounds. We refer more particularly to such terms as the following :—*Dichotomo-patento-ternate ; clavato-attenuato-cylindrical ; inflato-fusiformi-acerate ; recurvo-dentato-birotulate ; inequi-furcato-triradiate*, &c. &c. The physiology of these creatures has been well worked out, and our author's observations demonstrate to certainty their decided animality. This is perhaps more clearly seen in the examination of the oscula than in any other instance.

> "The oscula are permanent organs, and are capable of being opened or closed at the will of the animal, and are subject to a considerable amount of variation in size and form, in accordance with the variation in the action of the sponge. Thus, in littoral sponges they are frequently entirely closed, and their situation even quite indeterminable during the period of their exposure to the air ; but when immersed in water, and the sponge is in the energetic action of the imbibition of nutriment, they are expanded to their full extent ; but when this action ceases, and that of gentle respiration only exists, many of them close entirely, and others exhibit apertures not exceeding half their former diameters while the imbibition of nutriment was in vivid action."

Dr. Bowerbank's views concerning the nature of digestion in these the lowest members of the animal kingdom are of the utmost value ; and since he does not hesitate to express his conviction that the process of digestion here is identical with that which occurs even in man himself, the matter assumes an important aspect. The writer, having shown the resemblance of the epithelium of the intestine of the higher animals to the sarcode covering the canals of the sponge, proceeds to the conclusion that these tissues are the sole agents by which food is digested and absorbed, and that in both cases (if we have caught his meaning) the particles of food become embedded in the sarcodic substance. After showing the similarity in structure which exists between sarcode and epithelium, he proceeds to describe how the molecules of food travel into the substance of the epithelium-sarcode, and become smaller and smaller as they approach the deeper tissues of the animal.

> "The mucous membranes of the intestines of a mouse, which was drowned in warm water to preserve the tissues during examination as nearly as possible in a natural condition, when examined by transmitted light with a microscopical power of 666 linear, presented the same characteristic appearances" [as those of sarcode of sponge under like circumstances—Rev.] "Some portions of the mucous lining of the intestine abounded more in particles than others; they also varied considerably in size, and were all more or less in a state of collapse, and some had the appearance of living and fully-distended vesicles. These molecules were not confined to the surface of the mucous or sarcodous matter, but were also embedded at various depths in its surface. They varied considerably in size and character within a small distance. At one place I observed a group of them, each being comparatively of considerable size, while at a little distance there was very rarely a large particle to be observed; and when they appeared to be of more than average number and size, they were observed to be at the surface of the mucous or sarcodous structure, as if they had not yet been absorbed and lessened in size by the process of digestion."

If this observation be confirmed, it will throw an entirely new light upon the hitherto obscure subject of digestive absorption, and we confess that, *à priori*, there seems every reason why Dr. Bowerbank's doctrine should receive favourable consideration. The accounts of the several tissues and organs, and of the functions of nutrition and reproduction, are equally instructive and full of original matter, but cannot be further referred to for want of space. However, they will well repay a careful perusal; and though they relate to the lower types of animal existence, they offer many subjects for contemplation to the physiologist, who, by investigating the animal functions in their simplest form and under the smallest number of associated conditions, cannot fail to be impressed with the belief that, a knowledge of the operations of life must be based upon an impartial examination of phenomena as they present themselves in all members of the animal kingdom. The present volume is accompanied by thirty-seven beautiful lithographic plates illustrative of sponge-anatomy, and we heartily commend it to the notice of our readers.

COMPARATIVE OSTEOLOGY.*

IT seldom happens that the man who gives himself up to original observation is also capable of occasionally assisting in the diffusion of that mass of knowledge which he has spent years in acquiring. Of course all who are familiar with the doings of the science world are aware, that when an original discovery has been made, or the anatomy of a creature has been worked out, the results are communicated to some of the learned societies. But, unfortunately, the information either remains locked up in the dusty volume of Transactions in which it was originally published, or else is taken up by some unskilled or unscrupulous vendor of what has erroneously been termed "popular" science, and so is transmitted to the public in a confused and mutilated condition. This we are sorry to think is the general rule; but there are exceptions to it. Here, for example, in the volume under notice is an instance. Professor Huxley, notwithstanding the extensive nature and number of the original inquiries in which he is continually engaged, sends us out now and then a proof of his desire to teach those who are outside *le monde scientifique.* He does not present himself like some persons we could name, in order to air his scientific reputation, and drown the earnest beginner in a flood of metaphysics and Greek derivations. He comes forward honestly to explain to the utmost of his abilities the great truths of philosophy, and, with as intense a contempt for what has been wrongly termed "popular science" as the stiffest of buckram savans could desire; he combines an equal scorn of barbarous technicalities, and a power of writing in such a manner as to leave his meaning within the grasp of the merest tyro: his lectures on "The Origin of Species," and his "Man's Place in Nature," are convincing proofs of this. The object of the present Atlas is "to aid students in comprehending the general arrangement of the bony framework of the vertebrata, and some of its most important modifications;" and this aim, we think, has been admirably achieved in the publication of the series of plates lying on our table. The arrangement of the figures is a good one, and is calculated to show at a glance the differences in the arrangement of the bones comprising the several apparatus depicted. The first five plates (each of which is a *double* quarto) are devoted to the representation of the crania of the different class of vertebrates. In them we find each skull viewed in several positions; seen from above, from below, from the side including mandible and in vertico-longitudinal section. Moreover, the crania of the different species delineated being represented side by side comparison is effected with considerable ease. In these five plates we observe drawings of the skulls of the following animals:—The dog, horse, sheep, pig, man, orang, baboon, howler monkey, Saimiri, hare, guinea-pig, ostrich, fœtal chicken, tortoise, turtle, tench, carp, alligator, lizard, boa-constrictor, menopoma, siren, pike, lepidosteus, sturgeon, shark, chimera, mud-fish, and lamprey. In plates VI., VII., and part of plate VIII. the vertebral series of bones are as fully represented as the cranial in the foregoing ones; the remainder of the eighth plate embracing a number of figures, showing the curious modifications of the hyoidean chain of bones seen in passing from man to the sheep, the gull, the lizard, and the codfish, in which latter it presents a very singular arrangement. Plates IX. and X. treat of the varied forms assumed by the fore-extremity (arm, forearm, and hand), as it presents itself in man, the gorilla, orang, spider monkey, marmozet, lemur, bear, lion, pig, rhinoceros, ox, horse, flying fox, dolphin, ornithorhyncus, eagle, penguin, apteryx, lizard, and turtle. Plate XI. shows us the pelvis and sacrum of a man, a gorilla, a gibbon, and a kangaroo; the hind foot of a zebra, a kangaroo, a two-toed sloth, and an eagle; and the pectoral arch, with the limb attached, of a skate, a tope, a siluroid fish, and a cod; the last plate comprising figures of the hind limb of each of the following animals:—Man, gorilla, chimpanzee, orang, spider monkey, marmozet, lemur, bear, lion, pig, rhinoceros, ox, and horse. The whole forms a beautiful and useful volume, of which we have only one ill word to say, and that relates to the manner in which the artist has performed his part of the work. We do not think Mr. Hawkins has done justice to his subject. The sutures are in no instance clearly marked and there is an absence of good definition, which we are sorry to observe.

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* "An elementary Atlas of Comparative Osteology," in twelve plates; the objects selected and arranged by Professor HUXLEY, F.R.S., and drawn on stone by B. WATERHOUSE HAWKINS, Esq. London: Williams & Norgate. 1864.

GEORGE AND ROBERT STEPHENSON.*

THE plan of double editorship of these volumes is most judicious. To Mr. Jeaffreson has been intrusted the personal history of these distinguished men. Though professing to be the life of Robert, a very large part of the working career, and much of the character of the father, are necessarily brought again before the public. Mr. Jeaffreson seems to have been very diligent and painstaking in tracing the early career of the father. During the latter part of 1860 he spent a great deal of time in Northumberland and Durham, gathering material from the oral communications of relatives, from the reminiscences of men who had been the companions or patrons of either George or Robert, from parish registers, or the account-books of collieries or factories. From these materials he has been able to correct so many errors which have appeared in other biographies of the elder Stephenson, that he found it necessary to rewrite his life so far as it was mixed up with the history of his son. Mr. Pole undertook to describe the great works in which Robert was from time to time engaged. This portion of the book takes up the life of Robert Stephenson at 40, and carries it on till its close at 55. The "Battle of the Gauges," "Iron Bridges," "The Britannia Bridge," "The High-level Bridge at Newcastle," "Chester and Holyhead Railway," "As Politician," "In London Society," "The Great Victoria Bridge," are some of the subjects selected by the biographer ; but the second volume in reality takes in the history of the railway system with all its fights before Parliament and with the public, together with a graphic description of the difficulties which had to be overcome when crossing rivers, or making levels to suit the prejudices of people, or to contend with natural causes. There are excellent portraits of George and Robert, and engravings of the Britannia, the Conway, and the High-level bridge at Newcastle, and of the Victoria bridge at Montreal. The book is in the highest degree interesting, and well worthy of careful study by all who have faith in steady industry and enthusiasm.

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* "The Life of Robert Stephenson, F.R.S., &c., late President of the Institution of Civil Engineers." By H. JEAFFRESON, Barrister-at-Law, with descriptive chapters on some of his most important professional works by WILLIAM POLE, F.R.S., M.I.C.E. Two vols. Longman & Co. 1864.

PRINCIPLES OF BIOLOGY.*

TO readers of modern philosophy Mr. Spencer is tolerably well known as a clever writer and a deep thinker. Anything, therefore, which claims his authorship has a fair chance of securing a favourable reception at the hands of scientific reviewers. The book which has now been issued by his publishers has been "coming out" in numbers for some considerable period, and constitutes only the first volume of a work which, if carried on upon the scheme already laid down, must eventually assume very formidable dimensions. Employing the term biology in its most comprehensive and accurate sense, to embrace all those phenomena relating to the subtle combination of forces to which we apply the term life, the author's aim has been to associate the various laws and theoretical inductions framed concerning the latter. Such has been his first object ; but his second one has been to demonstrate, from a careful analysis of those laws, and from an effort to show their marked correlation, that life, in its varied and numberless forms, is but the result of a grand process of evolution. In working out this problem, Mr. Spencer is but following in the footsteps of the more distinguished modern men of science, and of course his labour has been in great part confined to collating evidence. The latter he has done in a manner highly creditable to himself ; and although in some few instances we observe statements which appear to us hardly supportable, still the writer is not to be held responsible for them. We wish, too, that in his next volume he would lay aside the style so common among writers upon metaphysics, and adopt a language more in keeping with the plain truths of science than that employed by him in some instances. Apart from the conclusions at which he arrives (and *we* shall not gainsay them), the book is, from the nature of the subjects which the author is obliged to introduce, full of interesting matter, which must prove highly attractive to the educated or even the ordinarily intelligent reader. We object to all definitions of life in the present state of science ; for inasmuch as we are yet unable to explain the processes of life in their entirety, a definition can be at best but a short expression of what we see going on within an organism. But we feel particularly opposed to accept the writer's definition, that "*Life is the definite combination of heterogeneous changes, both simultaneous and successive.*" It seems to us that even in the course of the development of a crystal there is such a combination as that referred to; besides, we think a simpler definition would be that life was *a condition of continual and simultaneous removal and supply of the particles composing a body.* Let either the process of removal or supply be impeded, and the condition presented by inorganic life is presented—in a word, *death.*

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* "The Principles of Biology." By HERBERT SPENCER. Vol. I. London: Williams & Norgate. 1864.

SKIN DISEASES.*

A BOOK like that which now lies upon our table has long been a desideratum, and we are glad to see that Dr. Fox has been the person to supply what was required. On a former occasion we had to notice a work by this physician, upon those cutaneous diseases which result from the growth of fungi, and in the present case we must speak as favourably as in the former one. The first chapter, which is headed "General Remarks," gives a sketch of the nature and limits of the subject of skin maladies, and throws out some important suggestions relative to the necessity of a careful study of the therapeutical agents used in those diseases; the six succeeding chapters embrace the consideration of the several true skin diseases, which, by the way, are grouped under the following classes:—Acute specific diseases, papular diseases, vesicular diseases, pustular diseases, squamous diseases, and tuberculæ or degeneration. The remainder of the volume is taken up with an account of the modifications of existing structures, and of parasitic diseases. There is one form of skin disease by which we are all attacked, though, fortunately for ourselves, at a period in which the faculty of memory is too feebly developed to hand us down an idea of the nature of our individual experiences. This affection is known to medical men under the awe-inspiring title of *Inoculated vaccinia*, and to the protectors of our infancy under the less imposing term vaccination. It is, of course, an artificially induced condition; but it, nevertheless, is a disease to all intents and purposes. As every one is interested in this branch of dermatology, we will quote a few paragraphs from Dr. Fox's work, which relate to the lymph with which we are infected, and the method of applying it, &c.:—"(1.) Get the lymph from a perfectly formed vesicle. (2.) Obtain it on the eighth day, before the areola is formed. (3.) From a healthy child. (4.) Vaccinate in several distinct places; the more vesicles produced by vaccination, the greater is the protective power. (5.) Use scarification with the lancet as the method. (6.) Do not vaccinate 'too many from the same arm.' (7.) Do not use matter taken from the adult or in (?) one who has been vaccinated before. (8.) Two months is the most suitable age for operation. (9.) Use lymph pretty recently taken." We regret to observe that Dr. Fox has not entered upon the questions of the physiological action of the lymph, and why the vaccination renders the individual operated upon less liable to small-pox than his fellows. The work, however, as we have stated, was much wanted, and we have little doubt its merits will be soon and extensively appreciated.

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* "Skin Diseases: their Description, Pathology, Diagnosis, and Treatment; with a copious Formulary." By TILBURY FOX, M.D., Lond., &c. London: Hardwicke. 1864.

"Photographs of Diseases of the Skin." Edited by BALMANNO SQUIRE, M.D. London: Churchill. 1864.

Another member of the rising school of dermatologists is Dr. Balmanno Squire, who has produced some photographic representations of skin disease, which, in a purely scientific aspect, are very beautiful. The first of Dr. Squire's series of photographs is now upon our table, and is accompanied by a page of letter-press, containing a description of the disease whose ravages are depicted in the illustration. The case was one of diffused psoriasis, and was successfully treated. The plate (which is coloured) represents the patient's limbs—the variety *diffusa* of the disease appearing upon one, and that of *guttata* upon the other. The appearances are tolerably faithful, but in our opinion the photograph would be more reliable if uncoloured. It is true it would lose much of its attractiveness; but if photography is to be employed in order to delineate peculiar conformations of parts, which cannot be portrayed with equal fidelity by the artist, it seems to us that the application of the painter's brush in order *mettre la dernière main* to the picture, leaves ample room for the cavils of the sceptical.

THE ANATOMY OF THE EMBRYO.*

ALTHOUGH to the general reader there is not much in this *brochure* which is calculated to be understood, it contains a great deal of very important information upon a matter which is full of interest for the physiologist. It is a fact which is strangely true, that Nature, in striving, as it were, to reach some final result, gropes her way along, as though devoid of the inventive faculty necessary to select the straight path. Of course there must be some grand reason for this, to us, anomaly; still, as regards our present knowledge, it is no less an anomaly on that account. The formative power (we use the expression only for want of a better one) does not proceed in a direct line toward the construction of any particular organ which is situate at the end of the series. On the contrary, it first shapes out of the formless blastema one particular structure, and then, as though having discovered that this does not suit the required end, it immediately breaks it up, and shapes from its remains an entirely new apparatus: this in its turn undergoes a metamorphosis, and perhaps in the next instance the sought-for object is attained. This fact is patent to the embryologist, and even the human anatomist is familiar with structures which he finds in organs that belong to the adult, and which he knows to be the ruins of some former stage of the individual's existence. There is no set of organs of more interest to him from this stand-point than that which comprises the *Wolffian bodies.* It is the history of these curious mechanisms which Dr. Banks relates; and we confess that, judging from his analysis of the observations of others, and accepting his own observations as sound, we see every reason for uniting in his general conclusion, that the *Wolffian bodies do not enter into the con-*

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* "The Wolffian Bodies in the Fœtus and their remains in the Adult," &c. By WILLIAM MITCHELL BANKS, M.D. Edinburgh; Maclachlan & Stewart. 1864.

struction of the reproductive system, as has been very generally conceived. Dr. Banks's essay is the reprint of a prize thesis; it is illustrated by a number of useful plates, and contains so full an exposition of the opinions of all who have written upon the question of the development of the *Wolffian bodies*, that it ought to be read by all who wish to be conversant with the literature of this subject.

PLURALITY OF RACES.*

THE works which the Anthropological Society has as yet published have been nearly as devoid of interest as of scientific value. It is, however, pleasant to find a book which, though devoid of the latter quality, is to some extent possessed of the former. Just such a one is M. Pouchet's treatise on the Plurality of Races. Full of anecdote, containing abundant quotations from the writings of travellers, and written in an easy and simple style, it is read with satisfaction till the cover has been closed; but when one comes to lay it upon the bookshelf, and the question arises, "What has this work proved?—to what conclusion has this man's writing urged me?"—the position arrived at is something like that in which a thoughtful person who has just read a highly-flavoured sensation romance is placed: the query is put, "Have I profited?" and the reply is decidedly in the negative. M. Pouchet wishes to prove that the several varieties of man which we find at present peopling the globe have not descended from a common stock. This is his proposition; but the only evidence adduced (which bears the faintest stamp of admissibility) to support this hypothesis, consists in a few statements based upon no reliable statistics, and to the effect that when white and dark races mix, the offspring are never normally prolific. All the phenomena which can be considered in a question like that which M. Pouchet fancies he has decided go to prove a very different conclusion from that which he has come to. Indeed, we are much inclined to believe that his own hypothesis of equivocal generation would, if established, go further to defeat his views upon the subject of human races than anything that has yet been brought forward. Notwithstanding that we differ from our author, we like his book; it is nicely written, and the translator has achieved his portion of the work very successfully. Our readers will do well to run through its pages.

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* "The Plurality of the Human Race." By GEORGES POUCHET, Doctor of Medicine, Aide-Naturaliste in the Museum of Rouen, &c. Translated and edited from the second edition by HUGH J. C. BEAVAN, F.R.G.S., Barrister-at-law. London: Published for the Anthropological Society by Longman & Co. 1864.

ELEMENTS OF CHEMISTRY.*

SUCH a work as that which is now before us needs no comment from the reviewer: it speaks for itself. Indeed, apart from this, Dr. Miller's treatise has already made a great name for itself, and is one of those books which are admired by the student for their comprehensiveness of detail, and their clearness of arrangement. Need we say that in its present edition (the third) everything has been done to bring the book up to the time, by modification and addition of matter? Extending as it does over nine hundred and forty pages, this must have been no light task. Yet that it has been satisfactorily executed, even a cursory perusal will convince the reader. In the former edition the new atomic weights were indicated by the employment of italics, but in this volume the more convenient barred letters have been substituted. This constitutes the more striking alteration of those portions of the text which have before appeared, and is alluded to by the author in a short prefatory note, in which he also mentions that the conversion of any formula on the new notation into that in ordinary use is effected by doubling the numbers attached to the barred symbols. The result obtained will then be either the ordinary formula, or its multiple by two. The section devoted to the photographic transparency of various media is extremely interesting, and contains the result of the author's original researches, published in 1862; in this we find it stated: (1.) That colourless solids, which are equally transparent to the visible rays, vary greatly in permeability to the chemical rays. (2.) That bodies which are photographically transparent in the solid form, preserve their transparency in the liquid and gaseous state. (3.) That colourless transparent solids, which absorb the photographic rays, preserve their absorptive action with greater or less intensity in the liquid and in the gaseous states. And (4.) That pure water is photographically transparent, so that many objects which cannot be obtained in the solid form sufficiently transparent for such experiments, may be subjected to trial in solution in water. We congratulate Dr. Miller upon the excellence of his second volume, and hope ere long to see the organic section in the hands of the public.

GARDEN BOTANY.†

THE author has written this volume for those who are interested, both in the examination of our native flora and of those plants which, though commonly cultivated in gardens, are not to be found wild in this country. We consider that he has accomplished his undertaking successfully, and the labour which the book evinces, speaks well for the industrious habits of the

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[*] "Elements of Chemistry, Theoretical and Practical." By William Allen Miller, M.D., LL.D., V.P.R.S., &c., Professor of Chemistry in King's College. Part II. Inorganic Chemistry. Third Edition. London: Longman & Co. 1864.

[†] "British and Garden Botany." By Leo H. Grindon, Lecturer on Botany at the Royal School of Medicine, Manchester, &c. London: Routledge. 1864.

compiler, who, we believe, has been for years engaged in diffusing a knowledge of Nature's works among the people of his neighbourhood. "Garden Botany" extends over nearly nine hundred pages, and since it describes all the species that it proposes to deal with, it must prove a useful addition to the libraries of those who may be included in that very wide section of the community—amateur botanists. The plan adopted in the arrangement of the letter-press is a good one, but is by no means original. In the first place comes an introduction to botany, in which the beginner is taught the names and characters of the various organs, &c., of the plant; then follows an analytical key, by the assistance of which a plant may with ease be referred to its natural order. Finally, the orders genera and species occupy the bulk of the volume. Mr. Grindon has conferred a boon upon the student by adding a general account of the mosses, lichens, fungi, charas, and seaweeds. We beg, however, to differ very decidedly from his assertion, "that no work has ever been published in which the 'Natural Orders' have been described in a way equally intelligible, or in which the idea and compass of the Natural System have been exhibited so fully for practical purposes." Bentham's "Handbook of the British Flora" will be found to possess all the qualities which Mr. Grindon so vehemently denies to all productions save his own; nay, more, a careful comparison of the two volumes will show that there is a wonderful similarity between them in everything, save date of publication. Thus in both we observe that the natural system is the one adopted; both possess analytical keys; in both the first portion is devoted to an outline of botanical science; and, finally, in both the genera and species are so arranged that the student, having ascertained the "order," proceeds to the identification of the species by employing a dichotomous scheme of analysis. Bentham's book, however, was published in 1858, and the volume under review was issued last year (1864). Of course, it by no means follows, from the circumstance that there are points of resemblance between the two books, that therefore the later one was constructed upon the model of the earlier; but it shows us that Mr. Grindon could hardly have been familiar with Bentham's essay when preparing his own. The volume is, nevertheless, a well-arranged and nicely printed one, and merits our highest commendation.

We regret that notices of the following works have been "crushed out" through want of space:—

"A Series of Metric Tables," by C. H. Dowling, C.E. London: Lockwood. 1864.

"The Astronomical Observer," by W. A. Darby, M.A., &c. London: Hardwicke. 1864.

"Bee-keeping," by the *Times* Bee-master. London: Sampson Low. 1864.

"Harmonic Maxims of Science and Religion," by Rev. W. Baker. Longman. 1864.

"Notes on the Errors of Geology," by John Kelly, V.P.R.G.S.I. London: Longman. 1864.

"Homes without Hands." Parts VI. to XII. Longman & Co.

SCIENTIFIC SUMMARY.

AGRICULTURE.

Value of Sewage as Manure.—It is well that the farming world should know that, although the sewage of large towns contains many of the ingredients of plants, and will, on the first application to a soil produce an increased crop, it is, nevertheless, not to be regarded as a true manure. Sewage does not contain all the mineral ingredients of plants, and hence cannot be depended on by the agriculturist for the restoration of the plant-ashes to the soil. These facts have very recently been urged upon the attention of the English public by Baron Liebig, who addressed a long letter upon the subject to Lord Robert Montagu, M.P. In what may be termed its natural state, says the Baron, sewage is not a universal manure like stable dung, which is efficacious at all times and in all localities, but a special manure, the continued application of which tends to impoverish the land. Stable dung contains all, a special manure only some, of the elements which ought to be restored to the soil in order to make it permanently fertile. Peruvian guano, for example, belongs to the class of special manures ; and experience has shown that in certain countries (*e.g.*, Germany and Scotland), the application of guano to meadow land, which produced, in the first year, enormous crops of grass or hay, had later no effect at all ; and that the same man who at first overrated the use of guano, eventually cursed its employment. Sewage contains ammonia, potash, and phosphoric acid, like guano, but phosphoric acid *in much smaller proportion.* On a soil rich (in its natural state) in phosphoric acid, sewage will have an excellent effect ; it will produce, for instance, large crops of grass, turnips, and corn if the soil supplies the quantity of phosphoric acid wanting in the sewage ; but, as in each successive crop a certain quantity of phosphoric acid is abstracted, the total quantity in the soil is, by continual application of the sewage, gradually diminishing every year, and a time must arrive when the phosphoric acid will be insufficient for further crops, and when sewage will cease to produce its former effects. Such being the probable results of the application of sewage *per se*, there are two things to be done : Firstly, it must be made intelligible to all that sewage matter in its natural state does not replace stable-manure, and that if used exclusively it will produce abundant crops *only* for a time ; secondly, the farmer must be made acquainted with the names of those ingredients which it will be necessary to add to the sewage in order to render it a permanent and useful manure. Baron Liebig suggests that—the composition of sewage being known—a recipe should be placed in the hands of the farmer, for the additional elements to be employed.—*Vide* Letter to the *Times*, November.

The Manure Manufactory at Aubervilliers.—This enormous factory is worthy of a visit from those agriculturists who occasionally take a summer's trip to the Continent. The consumption of animals is something enormous, and is per annum as follows :—Eight thousand horses, two hundred donkeys, three hundred cows, three hundred pigs, nine thousand cats and dogs, six thousand kilogrammes of meat unfit for use, five hundred thousand kilogrammes of offal from the *abattoirs* of Paris, and six hundred thousand kilogrammes of other refuse animal matters, such as skins, horns, hoofs, &c. The raw material is first cut up and boiled to extract the grease. The flesh is then separated from the bones, pressed, and dried ; it is afterwards ground and sifted, and the dried bones (which are next submitted to the same process) mixed with it, forming a manure containing thirty-five per cent. of nitrogen, and fifty-five of phosphate of lime. The blood is collected separately, and also made into manure. The solution obtained by boiling is strained, and the solid matter thus produced is added to the rest. The offal is piled in alternate layers with other organic matter, such as wool and parings of hoofs and horns, and with them is mixed a quantity of phosphate of lime. The heap is then moistened with some of the solution obtained by boiling, the whole is set fermenting, and, eventually, a very valuable manure is produced. During the process the phosphate of lime breaks up into various phosphoric compounds, and several ammonia salts are also formed.

Relation of Ingesta to Egesta in the Feeding of Cattle.—The following are a few of the conclusions at which Mr. J. B. Lawes has arrived in reference to this subject :—

1st. During the fattening process the proportion, in a given weight of the body, of water, mineral matter, and nitrogenous compounds, decreases, whilst that of the fat very considerably increases.

2nd. The carcase parts or saleable meat increase more rapidly than the internal parts or offal.

3rd. The amount of dry substance of food required to produce a given weight of increase is larger with the ox than with the sheep, and larger with the sheep than with the pig.

4th. The dry substance of the food of the ox contains a larger amount of indigestible matter than that of the sheep ; and that of the sheep more than that of pigs.

5th. Oxen require from five to six, and sheep from three to four, times as long a period to add a given proportion to the weight of their bodies as pigs.

6th. The greater portion of the nitrogenous and mineral matters of the food is recovered in the manure ; and the greater part of the non-nitrogenous substances is lost by respiration and other exhalations—a much smaller portion being retained in the increase or voided in the manure.

7th. For a given amount of increase produced, oxen void considerably more substance as manure, and expend more in respiration, &c., than sheep ; and sheep very much more than pigs.

8th. For a given weight of dry substance consumed, oxen void more as manure than sheep, and sheep much more than pigs ; but oxen respire rather less than sheep, and sheep rather less than pigs.

9th. In proportion to a given weight of animal, within a given time, oxen both consume and respire less dry substance of food than sheep, and sheep very much less than pigs, but they void almost identical amounts of dry substance as manure.—Vide *The Dublin Quarterly Journal of Science*, No. XVI.

Verdict against the Nitrogen Theory.—A writer in one of the American scientific journals, in reviewing the various discussions which have, during the last ten years, taken place in this country between Liebig on the one hand, and Messrs Lawes and Gilbert on the other, brings in a clear and decided verdict in favour of the former. Adopting the expression *cinereal*, instead of mineral or inorganic, to embrace all the elements found in the ashes of plants, he observes, "the 'good substitute' for *cinereals*, put forth in 1851, has had a fair trial, and has failed. Ammonia, judged by the experiments of its advocates (as well as by many other trials), proves not to be, as was alleged, a 'specific' manure for corn. The 'specific' value of potash and the phosphates for leguminous and root crops respectively, stands equally disproved. Corn and meat cannot be continuously exported from soils for 6,000, 2,000, or 1,000 years without restitution (respectively) of the silica potash and phosphates removed in their tissues from the soils. These illusory views, which their advocates (to do them justice) have already, to a large extent, honourably renounced, must be utterly abandoned. The celebrated nitrogen theory is at an end, and with it falls also the doctrine of 'manurial specifics.' We now know that the costliest ammonial salt, and the cheapest and commonest of the cinereals (say, for example, silica or lime), judged by the spongiole of a plant's root, are of precisely equal value : each priceless so far as essential to the plant's nutrition, each worthless as to every molecule beyond."—Vide *The Canadian Naturalist and Geologist*, new series, vol. i., No. III.

How to use Sewage Matter.—An eminent authority has lately written a pamphlet to show that should the sewage matter be allowed to accumulate and be then distributed by canals of irrigation, considerable danger to the health of the population must arise. He recommends that means should be adopted to clarify the sewage liquid and retain the sedimentary matter, so as to form a portable dry manure. This view he supports with very powerful arguments, and with a degree of logical acumen not very often found in semi-scientific pamphlets, and urges upon the Metropolitan Board of Works for its adoption.—Vide *The Utilization of Sewage.* By I. Alex. Manning, of the Inner Temple. London : Hatchard.

ASTRONOMY.

Changes in the Lunar Surface.—Mr. Webb gives some curious observations respecting the discrepancies which he remarks in Beer and Maedler's map of the moon, and is afraid that, although the position of the mountains is accurately given, the details depending on the eye-measurements and sketches are not equally trustworthy. In a work of such magnitude this is scarcely to be expected, and corrections must be made, from time to time, by those who possess better instruments and concentrate their attention on one particular district. Mr. Birt finds that the greatest deficiencies occur at the edges of the moon, where, from the crowded position of the mountains produced by the foreshortening, they are most likely to be found. It is clear, however, that in minor points Maedler's map cannot be trusted when suspicions of change are in question, as it omits some craters which are given in maps published previously. Thus Schroeter's delineation of the mountain *Kaestner* is more correct than Maedler's, and the craters in the *Sinus Æstuum* given by Lohrmann are not found in the later constructed map. To those cases Mr. Webb adds the following :—In the mountain *Helicon* there is a crater lying close to the ring on the S.E. side, and another very minute one on the east wall. Another is in the *Mare Imbrium* in the direction from *Helicon* to *Archimedes*, and is insulated in the open plain. One, of an elliptical form, which contains a distinct shadow, is found between *Kirch* and a similar crater in the N.W., and there are other minute craters in the *Mare Imbrium* not given by Maedler. There is a small crater on the north end of the crater *Delisle.* To the S.E. of *Diophantus* there is a conspicuous but small crater. In the mountain *Copernicus* the S. and S.W. slope is thickly studded with very minute craters, which form a continuation of the similar district lying between *Copernicus* and *Eratosthenes*, and which Mr. Webb thinks has assumed its present aspect during the present century. In the remarkable convex interior of the mountain *Mersenius*, in which Maedler states that a central mountain is totally absent, Mr. Webb detected a minute crater with a small telescope as far back as 1836, and he has since found that it was noticed even earlier by Lohrmann. Craters which were seen by Schroeter in 1797 in the interior of *Gassendi*, and by Mr. Webb in 1863, are not mentioned by Maedler. It will be seen from the foregoing how difficult it is to discriminate between errors of drawing and real physical change on the lunar surface.

Meteors on the Sun's Surface.—It will be remembered that a few years ago, whilst viewing the sun through a telescope, Mr. Carrington perceived a meteor passing across the disc. This was at his observatory at Redhill ; but the appearance was independently seen and described by Mr. Hodgson, at London. A similar phenomenon was noticed by Mr. Brodie, of Uckfield, at 10·30 a. m. of October 2. The length of its path in the field of view was about one minute of arc, the breadth of the head about four or five seconds of arc, and the duration of its visibility about three-tenths of a second. It first appeared at the lower part of the field of view, and passed nearly vertically towards the centre. It had a slightly curved tail, with two very considerable "serrations" on its eastern edge. Mr. Brodie describes it as a very brilliant body, far surpassing in lustre that of the sun itself. As the telescope has an object-glass of 8½ inches aperture, and the eye-piece specially adapted for looking at the sun, and found to be in good order, there can be no doubt in respect to the reality of the appearance.

Bright Band round the Moon's Edge in Solar Eclipses.—Professor Challis recurs to this subject in the last number of the Astronomical Society's notices. He now admits with Professor Airy that this bright band cannot be explained by refraction through a lunar atmosphere. He has examined three of the photographs taken of the last solar eclipse by Professor Alexander, and finds that, when they are looked at too closely or too distant, for distinct vision, a white band not only appears round the edge of the moon, increasing in intensity towards the cusps, but also in the interior of the sun's border. On viewing them with distinct vision, the bands, however, disappeared entirely. But at the same time a narrow luminous fringe, not of uniform breadth or brightness (the latter increasing towards the limb), was seen surrounding the moon, but could not be detected on the sun. He likewise tried the effect of pasting a piece of the dark photographic paper across the bright lune, and also saw the luminous band at its edges. Professor Challis is of opinion that the bands and the fringe are different phenomena, the former being due to indistinct vision, whilst the latter is plainly seen. It is clear that it is not due to photographic effect, as it has been seen by eye-observation, both by Mr. De La Rue and Professor Argelander. It has been stated, however, that the same sort of fringe is sometimes observed in photographs of mountain scenery along the dark outlines, and it has been surmised that it is due to the illuminations of the atmosphere from light reflected beyond the dark boundary from the innumerable facets of objects. He is of opinion that the corona and red flames cannot be accounted for by the reflection of the light of the photosphere from the solar atmosphere, but thinks that the ether in its neighbourhood may be so disturbed that it may become luminous, and adduces the great height of the *Aurora Borealis* as a case in point, which is sometimes found to be much greater than the supposed limits of the earth's atmosphere.

Object Glasses of Telescopes.—Mr. Pritchard is of opinion that the new form of telescope which was proposed by Gauss, and put in practice by Steinheil, and which gives a large aperture with small focus, has nothing peculiar in its properties which may not be attained by using the formulæ of Sir J. Herschel, published many years since. It is remarkable that the latter, when calculated in two different ways (which it may be), can lead either to the Fraunhofer or Steinheil form, and that "there are always two object-glasses of two different forms which have the same amount of spherical aberration for the same material, apertures, and focal length." The convex-concave crown glass of Steinheil corrected by the same form of flint, but in which the convex anterior surface of the *object-glass* is less curved than the other, which is concave, co-exists with that of Herschel, composed of a double convex crown, corrected by concave flint. Mr. Pritchard considers that the ordinary Herschel form is preferable to that of Gauss and Steinheil, as a very slight error of radius in the flint lens of the latter would destroy the goodness of the object-glass. Mr. Pritchard advises the imperative necessity of a careful determination of the indices of refraction of the glass employed, an error of the third decimal place being quite sufficient to endanger its performance. He is of opinion that the thickness of the lenses is not so material, but that when the diameter of the glass exceeds six inches, great care is necessary even in this respect.

New Planet.—The latest discovery in this branch is the planet (81) which was detected by M. Tempel, at Marseilles, on Sept. 30. It has received the name of Terpsichore, and when first seen was estimated of the 10th magnitude.

Comets.—The comet discovered by Professor Donatis, at Florence, on Sept. 9, and which is the third found this year, passed its perihelion on July 27. The second comet of 1864, discovered by the same astronomer, on July 23, passed its perihelion on Oct. 11, 1864.

Self-registering Thermometer.—Mr. Hamilton, of Liverpool, has invented a very ingenious contrivance for this purpose. A vessel, containing air, is counterbalanced by a barometer tube, by means of a string passing over a pulley. The ends of each dip into two vessels containing mercury, in which the surfaces are at the same level. The instrument will not be affected by changes of atmospheric pressure, but any changes of temperature will change the volume of the air in the vessel and cause it to rise or fall.

BOTANY.

A New Irish Plant.—It is known to botanists that the flora of Ireland is in many ways peculiar, and more especially in relation to the circumstance that certain of the plants it includes are not only absent from this country, but are found in various portions of the Continent. Dr. D. Moore now adds another to the number of Continental plants found in Ireland. The new addition is *Potamogeton nitens*, one of the aquatic monocotyledons. It seems to hold a place between *P. heterophyllus* and *P. prælongus*, but it may be distinguished from the former by its broader lower leaves, half embracing at the base, channelled and reflexed, its peduncle denser and shorter, its inflorescence and the absence (in July and September) of floating coriaceous leaves. From the latter it is known by its shorter leaves not hooded at the point, and lengthening into a foot-stalk at the base. *P. nitens* was discovered in considerable quantity in a large lake at a short distance from the sea, near Brandon Mountain, co. Kerry. In the beginning of last July it was scarcely in flower, and about the middle of September specimens collected presented the fruit in a condition of immaturity, yet ready to drop from the parent plant.—Vide *Journal of Botany*, No. XXIII.

The Canadian Flora.—In a paper upon this subject, Dr. George Lawson describes the divisions of what he terms the floral carpet of North America. In some districts the vegetation is more developed than in others. Thus in the northern portions of Canada there are distinct indications of a thinning of this carpet. In the south-western peninsula of Canada there is a luxurious vegetation, composed largely of species which have their head-quarters farther south, in the adjoining states. In this locality there are magnificent tulip trees, and black walnuts, the occidental plane, and such little southern plants as *Jeffersonia diphylla*, *Azolla Caroliniana*, and *Erigenia bulbosa.* This is the peach country of Canada, and the part peculiarly adapted for the grape-vine, tobacco (now extensively cultivated), and Indian corn, all of which require in Canadian latitudes a maximum of summer heat. Gooseberries do not thrive, and although the soil is peculiarly adapted for turnip culture, the climate is too warm and dry. In like manner oats, broad beans, and cabbages give way before wheat, kidney-beans, and pumpkins, all of which enter largely into field culture. In the south-western peninsula of Canada there are other plants that have a rather wider range northward and eastward; such are *Lupinus perennis*, *Ranunculus rhomboidens*, *Castilleja coccinea*, *Asplenium rhizophyllum*, *Woodwardia*, etc. *Viola sagittata* is common about Toronto, but rather a local than a southern or western plant, and *Podophyllum peltatum* extends sparingly to Lower Canada. The prevailing and characteristic trees of Upper Canada are the beech, maples, several species of oak, ash and birch, hickories, iron-wood, blue-bark, butter-nut, pines, hackmatack, cedars, hemlock, balsam fir, poplars, and wild cherries; spruces increase to the eastward. Of essentially American species which form the great mass of the Canadian flora, the Solidagos Asters, and other showy compositæ, are conspicuous. It is along the southern and south-western frontier of Canada that there exists the greatest number of plants of the true American flora, which is a Continental flora, developed chiefly inland, and decreasing toward the Atlantic sea-board. There are many examples of this in Nova Scotia, but in that locality the preponderance of *northern* species is much greater than in the corresponding latitudes in Canada, and many of our common plants are in western Canada, either entirely northern, or strictly confined to the great swamps, whose cool waters and dense shade form a shelter for northern species. This effect of the swamps in modifying the distribution of species seems to have been hitherto overlooked. Dr. Lawson observed that, in localities in which boulders were largely distributed, there were always certain plants which he terms *boulder*-plants to be found.—Vide *The Transactions of the Nova Scotian Institute of Natural Science*, vol. ii. part i.

The Origin of our Local Floras.—On this subject an article appeared in our last number. This contribution was accompanied by a plate, in the execution of which the lithographer did not exactly carry out the directions of the artist concerning certain variations of shading. We therefore beg to call our readers' attention to the following erratum, which arose from the want of correspondence between the drawing and the description in the text:—Page 36, lines 6 and 7 from top, *instead of* "The unshaded and most deeply shaded parts of Plate II." *read* "Areas I. and II. of Plate II."

New British Lichens.—The Rev. W. A. Leighton records the discovery of some lichens new to Britain. The most remarkable of those recorded by this botanist is *Thelocarpon Laureri.* This curious species was first discovered by Flotow, in 1824, in marshy places near Glatz in Germany, and his specimens appear to have lain in his herbarium, undetermined, until 1846, when M. Laurer again found the lichen on turf fences, and drew M. Flotow's attention to it. The latter gentleman then described it under the name of *Sphæropsis.* Mr. Leighton's specimens were discovered upon a single decorticated larch rail at Middletown, near Craig-Breidden, in Shropshire, in June last; and in August it was found growing parasitically upon the thallus of *Bœomyces rufus* on Stipertones Hole, and also on larch rails near the cemetery, Shrewsbury. In all these localities it occurred in very small quantity, and subsequent repeated researches have hitherto failed to detect more of it. Its extreme minuteness is doubtless the cause of its having been heretofore overlooked; but now that attention has been drawn to it, it will most probably be found to be by no means uncommon. At first sight it resembles the granules of the thallus of *Trachylia tigillaris,* in a young scattered state, but the microscope and dissection show such appearances to be mere resemblances.—Vide *Annals of Natural History*, December.

The Development of Composite Flowers has recently been minutely studied by Professor Wolfgang, who gives the following information concerning it:—The flowers which constitute the head are developed subsequently to the leaves of the involucre, in a direction from the circumference of the receptacle to its centre. The first traces of leaves appear in the form of oblique prominences, directly continuous with the epithelium of the receptacle. The future point of the flower, however, does not correspond to the point of this prominence. These rudimentary parts afterwards become completely hemispherical ; the developmental point of the bud remains behind in its growth, whilst around the apex there is formed a circular elevation which soon forms a sort of crater. On the outside, a little above the annular rampart, there appear sometimes certain cushion-like elevations, which are probably the rudiments of the subsequently-obliterated calyx. There is at this period no trace of the pappus. Next the five petals originate on the margins of the crater wall ; their increase takes place at the base, and they curve inwards successively in a peculiarly bent manner. The anthers follow then, alternating with them, and are developed on the inner slope of the crater. The petals become soldered together, from the base up to the place where the lobes afterwards make their appearance. The pappus projects from the outer wall of the crater margin, but not until the anthers have advanced considerably in their development ; from its origin and nature it must be regarded as an accessory organ. The ovary, which is decidedly inferior, is produced by the growth of a sort of disk of vegetable tissue. The ovule is lateral ; the succession of the development of the leaf-cycle (?) is altogether abnormal.—Vide *Bibliothèque Universelle*, October.

Rhaphides as Diagnostic Characters of Plants.—Professor Gullin still pursues his inquiries upon this subject, and describes the crystals which he has found in the species of various orders. His description of the crystals which occur in the wood or bark of Quillaja is of interest. In a sample which the Professor obtained from Messrs. Butler & McCulloch he found crystals lying in great numbers along the liber and mesophlæum. They are generally about the $\frac{1}{160}$ of an inch long, and the $\frac{1}{1600}$ of an inch thick, four-sided rectangular prisms, whose faces are equal to each other, and whose ends are topped with small pyramids ; but they vary in form. Their ends may be like the edge of a chisel or wedge, and occasionally as if the shaft of the crystal has been cut through obliquely from one angle or face to the opposite one ; besides, the prisms may be triangular. Though they are so very plentiful, they occur, for the most part, singly, sometimes two or three partially fixed together, and never in bundles, in which character they further differ from true raphides, and closely resemble many of the crystal prisms of Iridaceæ and certain other Monocotyledons. Quekett describes each separate prism of Quillaja as having a *close* investment or cell, but no *loose* one, of cellulose.—Vide *Annals of Natural History*, October.

Abnormal Orchids.—Mr. Maxwel T. Masters, in a letter to the editor of *The Journal of Botany*, thus describes some very curious specimens of *Orchids*, lately forwarded to him by Dr. Moore. The flowers examined had three sepals as usual ; within these a double and in some instances a triple whorl of petals, most of the latter being lip-like in form and colour. No trace whatever could be found of ovary or column, pollen or nectary, but, standing up in the centre of the flower, in the place usually occupied, was a small raceme consisting of numerous bracts subtending a number of flower-buds. These latter were made up (so far as their structure and arrangement could be observed) of three sepals enclosing some rudimentary petals, and then again encircling a prolonged axis with minute bracts and rudimentary flowers. The smallest of these tertiary flower-buds examined measured $1\frac{1}{10}$ inch in diameter, and consisted merely of a central dome or pimple of cellular tissue, encircled at the base by a shallow cup, whose edge was slightly three-lobed, the lobes indicating possibly the future sepals. In other minute buds the central dome was surrounded at the base by a four, five, or six-lobed cup. So far as Mr. Masters is aware, these flowers present the only recorded instance of *median floral prolification* in Orchids.—Vide *The Journal of Botany*, November.

The Process of Ripening in the Corn-grain.—A memoir upon this subject, which possesses features of interest both for the agriculturist and botanist, was presented a couple of months since to the French Academy. The writer, M. Isidore Pierre, endeavoured to show the relation which exists between the various constituents of an ear of corn, in regard to increase in weight. His experiments were made upon plants in which the process of fertilization had terminated, and in which the seed could be separated from the surrounding husk, and were carried out upon specimens of various ages, intervening between the stage alluded to and the fully matured condition. The results of his inquiries go to prove that, up to the latest moment the grain continues to increase in weight, as also does the entire ear ; but that those portions of tissue which surround the seed undergo a diminution of weight proportionally to their age. Thus, while a certain volume of corn cut on the 25th July weighed 2735·6 kilogrammes, that gathered on the 6th of the same month weighed only 1537·1 kilogrammes. This shows the *absolute* increase ; but the *relative* change is still more remarkable. In the volume collected on the 5th of July, the grains alone weighed 755 kilogrammes, and the other parts, taken together, 781·4 kilogrammes ; but in that examined on the 25th of the same month the weight of grain amounted to 2070·4 kilogrammes, whilst that of the surrounding parts did not exceed 665·2 kilogrammes. The important feature in this observation is the absence of a direct ratio of increase to decrease. Hence follows the important conclusion, that, in the process of ripening, the grain does not derive its increased weight of matter solely from the surrounding parts. According to M. Pierre's ideas, the supply of additional matter is derived from the stem, and especially from that division of the upper portion which lies between the ear and the first upper joint or node. Another of the writer's observations relates to the relative quantities of mineral matter and nitrogen which the dried grain possesses when the plant has been cut early and late respectively in the season. In the specimens gathered on the 5th he found, per kilogramme, 25 grammes of mineral matter and 18 grammes of nitrogen, but in those collected on the 25th he found but 19 grammes of mineral matter and as many as 22 grammes of nitrogen.—Vide *Comptes Rendus*, October 31st.

Importance of the Study of the Development of the Algæ.—A very valuable article which, under another title, bears most decidedly upon the necessity of studying the development of the so-called unicellular plants, in order to lead to their correct identification, has been contributed to science by Dr. Braxton Hicks's, F.R.S., Commentary on Mr. Archer's beautiful papers upon *Palmoglœa*, abstracts of which will be found in Vol. III. of this Review. He shows that no one set of characters is sufficient to prove the individuality of one of the unicellular plants. How, says Dr. Hicks, "is a single cell to be distinguished from another single cell? What reliable characters are to be fixed upon as of generic value? When we consider through what various forms those cells pass whose life-history has been carefully watched—as, for example, *Protococcus pluvialis*, the very species with which Mr. Archer illustrated his paper,—how are we to tell to what genus any single cell belongs? How can we tell whether it be a fixed form, a separate entity, or merely a transitional form of some other growth? When, again, we find, as I have shown, that cells quite similar in all respects are produced during the segmentation of the gonidia of the Lichens, Mosses, Lycopodia, Prasiola, &c., in what manner, may it be asked, are we to tell to what group the cell belongs, and how can we say that it is certainly a separate palmellaceous plant?" From these queries it is quite evident that Dr. Hicks means to contend that the only clue to the true nature of such plants is a study of their development—a knowledge of their various transitional phases. Respecting the characters upon which considerable weight has been laid, the writer concludes that none of the following can enable the observer to identify the cell as belonging to a particular species:—

1st. The position of the nucleus.
2nd. The size of the cell.
3rd. The disposition of the chlorophyll.
4th. The form of the cell.

The first is useless because in certain forms the nucleus is absent; the second, because size depends upon a variety of conditions, such as temperature, the rate of segmentation, &c.; the third, because in many forms the contents are quite homogeneous; the fourth, because the variety of forms is almost unlimited. Dr. Hicks terminates his remarks upon this portion of the subject by asking:—"Upon what, then, are we to fix? No answer seems practicable but that which I have already indicated, namely, upon the gradations assumed during its whole life-history. If it be asked, How can this be attained? it must be honestly answered,—with much labour and careful observation. Better trace one form well than endeavour to attain an apparently large result by that which cannot be relied upon, although it may have the attraction of being definite."—Vide *Quarterly Journal of Microscopical Science*, October.

CHEMISTRY.

A New Method of estimating Carbonic Acid has recently been announced by Messrs. Tyndall and Barrett, of the "Royal Institution." It appears that the air expired by the lungs, and which contains carbonic acid in considerable quantity, can be more minutely and accurately analysed and examined by physical than by the ordinary chemical means. The new method is based upon the fact that carbonic acid, although in regard to the ordinary sources of heat a feeble absorber, becomes a very powerful one when the caloric is developed by carbonic oxide flame. The following is the way in which the experiment proving the accuracy of the new process was performed by Mr. Barrett. A small flame of carbonic oxide is caused to burn regularly within a glass globe. The latter has an aperture on one side opposite to the flame, which allows the radiation to pass unchanged into a brass experimental tube, which is fixed horizontally in front of the lamp. The radiation from the flame, after passing through the experimental tube (which has been previously thoroughly exhausted of air) falls on a thermo-electric pile and deflects the needle of a suspended and delicate galvanometer. In the next instance this deflection is neutralized, by placing before the opposite face of the pile a cube containing water kept boiling, and also by the careful adjustment of a double metal screen. If an absorbent gas is now admitted into the tube, the balance is disturbed, and the needle is deflected in proportion to the absorbing power which the gas possesses. In this way the portion of the arc through which the needle travels, indicating the extent of the disturbing power, enables the observer to calculate the per-centage of the gas present. Should this discovery be capable of practical application, it would be of immense advantage to have a machine upon this principle attached to all hospitals for diseases of the chest, as by its means the physician would be enabled to perceive some important phenomena in connection with the function of respiration, which, were an ordinary analysis necessary, would be placed quite beyond his reach. We understand that from one experiment, Messrs. Tyndall and Barrett ascertained that the air of their laboratory, compared with that from the Downs of Brighton, possessed an excess of absorbing power which was equivalent to four per cent.

The Extraction of the Aromata of Flowers.—At the autumn meeting of the Pharmaceutical Conference, an interesting communication was read by Mr. R. C. Tichborne, upon the best means of preserving the odorous principles of flowers. Having observed the faculty which glycerine possesses of preserving vegetable as well as animal substances, he packed different kinds of scented flowers in jars and covered them with this fluid. Some specimens were kept in this way for two years, and when the glycerine was removed, it was found that the volatile oils had been extracted by it, and on distilling it a liquid vastly superior to the ordinary "water" was obtained. Mr. Tichborne recommends the following as the best process for the removal of the volatile oils :—After macerating the flowers for some considerable time in glycerine, the latter is expressed and is again treated with fresh flowers, until the excipient is thoroughly saturated with the *otto* (the extraction appears to be complete, as the glycerine has a decided affinity for the volatile oils). The saturated glycerine is then diluted with water, and shaken with a small quantity of chloroform. After frequent agitation, the latter is allowed to subside, when it is found to have carried down with it nearly the whole of the essential oils. This chloroform solution, after being separated by a funnel, should be filtered and allowed to evaporate spontaneously in a shallow vessel: the residual matter when dissolved in spirit forms the spirituous extract of the flowers. When operating upon large quantities of flowers, it becomes necessary, for economy's sake, to drain off the greater portion of the chloroform by means of a still. This does not injure the extract, because the boiling point of the chloroform is very low. The glycerine may be used over and over again, by diluting it, passing it through charcoal, and finally evaporating it till it attains its proper specific gravity.

Dialysis in the Examination of the Constitution of Plants.—It has lately been stated that when the juices of plants are placed upon the dialyser the mineral elements are readily obtained. In the course of some experiments, made with a view of proving the accuracy of these assertions, the following results were obtained :—The tops of the common potato yielded crystals of nitrate of potash, some cubes of chloride of potassium, hexagonal crystals not analysed, sugar, and an ammonia salt. The "deadly nightshade" gave nitrate of potash, an unknown magnesia salt in square prisms, and sugar. The common garden lettuce contained crystals of nitrate of potash, tetrahedra of undetermined composition, sugar, and ammonia. Cucumbers furnished sugar, ammonia, and sulphate of lime. Cabbage gave sulphate of lime and ammonia ; and the thorn-apple contained so much nitrate of potash, that dried portions quite deflagrated on being ignited.—Vide *Chemical News*, Oct. 22.

Copper Salts sensitive to Light.—An important observation has been made at Berlin to the effect that certain salts of copper have the property of undergoing rapid change under the influence of light. This property was recently pointed out by Herr Grüne, in a paper which was read before the principal photographic society of Prussia. A copper surface, when cleaned with hydrochloric acid, rapidly tarnishes, even after being well washed in water, and it never acquires as much brilliancy as when cleansed with sulphuric acid. This fact, though known for some time, was not explained upon the view that chloride of copper is sensitive to light until Herr Grüne took it into consideration. Having often repeated the experiment of exposing ordinary culinary utensils to the action of light, he thought one day of preparing a copper plate in a similar manner, covering it with an engraving and exposing it to the direct rays of the sun. After a few minutes' exposure the design appeared upon the copper as a negative, and remained upon the plate for an hour after it had been exposed to the influence of diffused light, but eventually faded. Repeated experiments satisfied the operator that commercial hydrochloric acid is preferable to that which is chemically pure. From an extended series of inquiries, Herr Grüne has been enabled to establish the following generalization :—*If we mix a concentrated solution of sulphate of oxide of copper with a solution of bichloride of zinc, a milk-white precipitate of per-chloride of copper is formed which blackens on exposure to light.* This precipitate, however, is sensitive only in its moist condition, and pictures obtained with it fade away when the substance dries. The only thing required now is a means of fixing the impression produced by light.—Vide *Photographic Journal*, Oct. 15.

Spontaneous Decomposition of Gun-Cotton.—In one of the numbers of the *Comptes Rendus* for September we find a paper by M. de Luca upon this subject. We merely call attention to it in order to show that Frenchmen not unfrequently make English discoveries, and publish them as if they were quite their own. In the memoir we refer to, the writer very clearly demonstrates that gun-cotton is exceedingly sensitive to the operation of light, and when exposed to the sun's rays undergoes decomposition into several new substances, which, however, he did not succeed in identifying. In concluding his paper M. de Luca observed, "When exposed to light and air, gun-cotton decomposes spontaneously, contracting in bulk without losing either form or texture. Eventually, however, the contraction increases, and then the resultant is a homogeneous substance, having a gummy aspect, and which splits up into a white compound like sugar, but of a sour character, and containing besides other materials glucose and *a new acid*." If the writer had given himself the trouble to consult the *Journal of the Chemical Society* before announcing his grand discovery, he would have found that he had been anticipated. In a paper read before the Chemical Society in 1863, Dr. Divers distinctly demonstrated the nature of the phenomenon observed when gun-cotton is exposed to light, by showing that this substance undergoes decomposition into *pectic* and *para-pectic* acids. In Vol. III. p. 108 of this REVIEW, the reader will find an abstract of Professor Divers's memoir to which we have alluded.

How to prepare Aluminium.—A very questionable process for the preparation of this metal has been described by a M. Corbelli. The clay from which the metal is to be obtained is first cleansed from stones, bits of wood, and other accidental impurities, and dried. One hundred grammes are then washed in nitric, sulphuric, or hydrochloric acid, in order to remove the iron which is usually present. The purified clay is next dried and heated in a crucible to 450° or 500° centigrade, and then 200 grammes of prussiate of potash are thrown in, and the whole is heated to whiteness. The button of pure aluminium is then found in the bottom of the crucible.

The Alcohols of Thallium.—M. Lamy, who claims (unjustly) to be the discoverer of the metal Thallium, has presented an exceedingly interesting memoir upon the above subject to the French Academy. The first compound which this chemist succeeded in obtaining was with a member of the Ethyl series, and to it he then gave the name of Thallic alcohol. Since discovering this he has studied it more carefully, and found it to be not only heavier than all known liquid *compounds*, but to possess greater dispersive and refractive powers also. In the hope of obtaining a liquid of a still more remarkable character as regards optical properties, he was led to examine a homologous compound, in which one of the Amyl series took the part of the Ethylic portion of the first, and found its properties not so extraordinary as those of the Ethyl compound. Finally, he was enabled to prepare a Methyl compound. The three combinations are termed respectively Ethyl-thallic alcohol, Amyl-thallic alcohol, and Methyl-thallic alcohol. Of these the two first are liquid at ordinary temperatures, and the last is solid. The first is the heaviest and (optically) most refractive and dispersive compound with which chemists are familiar. It crystallizes at about 3° below zero, and is prepared as follows :—Place a large excess of absolute alcohol in a large flat-bottomed vessel under the receiver of an air-pump, and place on a wire gauze above the liquid a number of thin plates of Thallium. Exhaust the air in the receiver, and put the latter in communication with a bag of oxygen by means of tubes, some of which are filled with sulphuric acid and pumice, and others with potash at 20° or 25° centigrade : the Thallium is rapidly transformed into a heavy oil, which falls through the alcohol to the bottom of the vessel. In this way, says M. Lamy, a hundred grammes of heavy oil may be easily produced in twenty-four hours. Amyl-thallic alcohol may be prepared in a somewhat similar manner, but with less rapidity; whilst the Methyl compound is produced in a granulated white precipitate, by pouring an excess of Methylic alcohol upon either of the other thallic alcohols. The three compounds burn with a bright green flame, leaving a residue which consists of black oxide, containing small globules of the metal. They are soluble in the alcohols from which they are derived, and in ether and chloroform, but are readily decomposed by water or even by the moisture usually present in the atmosphere : in such cases the alcohol is disengaged, and hydrated oxide of thallium is deposited. — Vide *Comptes Rendus*, Nov. 7th.

The Decomposition of Formic Acid.—M. Berthélot continues his researches upon this matter, and states that he causes the organic acid to split into either carbonic oxide and water or carbonic acid and hydrogen, the difference depending apparently upon the completeness of the process. If only a portion of the formic acid be decomposed, then the products are carbonic oxide and water ; but if the whole of the acid is broken up, then there result carbonic acid and hydrogen. In concluding his paper M. Berthélot draws these two conclusions :—

" 1st. Formic acid in vapour when submitted to an elevated temperature is decomposed with evolution of intense heat.

" 2nd. Formic in vapour, when acted on by a high temperature, becomes converted (according to the experimenter's will) into either carbonic *oxide* and water, or carbonic *acid* and hydrogen."—Vide *Comptes Rendus*, Nov. 14th and 21st.

The Detection of Nitro-Benzol in Oil of Bitter Almonds.—M. Dragendorff asserts that nitro-benzol is very easily detected by acting on the adulterated oil with sodium, in the presence of alcohol. This metal in contact with pure oil of bitter almonds disengages gas, which is increased by the addition of alcohol, and white "flocks" are formed. Nitro-benzol, under the same circumstances, with alcohol, becomes deep brown or black and viscid. In testing the adulterated oil, take ten or fifteen drops of it, add four or five drops of alcohol and a piece of sodium ; a brown deposit, approaching black in proportion to the amount of nitro-benzol present, occurs. This reaction is instantaneous, and when from 30 to 50 per cent. of nitro-benzol is present, a thick brown liquid is produced by the above application in less than a minute.—Vide *Journal de Pharmacie and Chemical News*, Nov. 12th.

Changes of Temperature produced by Mixing various Liquids.—At the sitting of the French Academy, which took place on the 24th October last, Messrs. Bussy and Buignet presented a paper detailing the conclusions at which they arrived from a number of experiments made upon mixtures of different liquids. The compounds which they especially investigated were ether, alcohol, bisulphide of carbon, acetic acid, chloroform, essence of turpentine, and distilled water. From these researches they conclude that :—

1st. When two liquids, capable of mutual solution in all proportions, are mixed together, a change of temperature is always observed ; the thermometer either rises or falls.

2nd. The effect observed is always the result of one or two causes acting in opposite directions. The one—affinity—acting upon the heterogeneous molecules, tends to produce heat. The other, acting upon homogeneous molecules, tends to produce cold.

3rd. When the two liquids have a feeble affinity, the effects of diffusion are then very strongly marked, and are indicated by a diminution of temperature.

4th. The elevation or diminution of the temperature varies only according to the nature of the liquids employed; they vary equally for the same mixture according to the relative properties of the two liquids which compose it.

5th. The influence of the relative proportions may even affect the thermometric result, so as to produce in the same mixture first cold and then heat. Five equivalents of alcohol, mixed with one equivalent of chloroform, produce an elevation of temperature amounting to 4·5 centigrade; whilst, on the contrary, a mixture of five equivalents of chloroform with one of alcohol produces a diminution of temperature equal to 2·5° centigrade.

6th. The initial temperature of the liquids when mixed has a sensible effect on the result in general: the higher the initial temperature the more marked is the thermometric fall.

7th. Liquids undergo a change of volume as well as of temperature when they are mixed. Sometimes they expand, as with alcohol and sulphide of carbon; sometimes they contract, as in the case of alcohol and ether.

8th. There is no apparent relation between the changes of temperature and volume; some mixtures which contract produce heat, while others which also contract produce cold.—Vide *Comptes Rendus*, October 24th, p. 673.

The Origin of Wine Ferments.—On this question M. Béchamp has been delivering his opinions, which may be thus summed up:—

1st. The presence of air is necessary neither for the development of the ferment, nor the commencement of the vinous fermentation. The grape itself brings everything necessary for the perfect accomplishment of all the phenomena.

2nd. The surface of the grape may carry the sporules and mycelium of the ferment.

3rd. The stalks and leaves of the vine may carry the same organisms as those spores, which may in fact be met with in the tissues of various plants.

4th. Fermentation may be set up in sugar by the introduction of grape stalks and vine leaves, or by the petals of the red poppy.

5th. Microscopic examination of the waxy matter on a ripe grape shows organized bodies, the same as those said to be produced in fermentation.—Vide *Comptes Rendus*, t. LIX., No. 15.

GEOLOGY AND PALÆONTOLOGY.

The Origin of Banded Flints has been a puzzle to geologists for the last fifty years, but we have now been enlightened upon the question by Mr. S. P. Woodward. All sorts of conjectures have heretofore been hazarded in explanation of the peculiar structure which banded flints present. Those with the furrowed surface were considered by Parkinson to be the petrified remains of the *Anatifa*, or duck-barnacle. Dr. Bowerbank, according to the writer's statements, considers them fossilized sponges: a view which is objectionable, because of the fact that, when slit and polished the banded portions show no microscopic peculiarity to distinguish them from the adjacent unbanded flint, and no organic structure, save where they invade the texture of a sponge, or envelop Foraminifera, so-called Xanthidia, and other minute organisms with their hazy shroud. Mr. Woodward considers that the bands in flint are produced by infiltration of mineral matters. "All kinds of siliceous pebbles derived from gravel beds are more or less affected by agencies to which those beds have been subjected, and especially they are liable to be stained by the penetration of water charged with iron or manganese, which has produced coloured zones and dendritic infiltrations in the most compact jaspers and agates, as well as in the more permeable flints derived from the waste of the chalk formation." Mr. Woodward's paper is accompanied by several beautiful illustrations representing sections of various specimens of banded flints, some of which may be seen in the British Museum collections.—Vide *Geological Magazine*, No. IV.

The Skin of Reptiles in the Fossil State.—There has been lately obtained for the British Museum, from Barrow-on-Soar, Leicestershire, a specimen of *Ichthyosaurus tenuirostris*, showing upon the surface of the slap a large extension of the dermal covering. It seems to indicate from the outline that these reptiles had a prominent ridge upon the dorsal surface, similar in appearance to that which the male of the pond-newt presents in the spring.

A Perfect Cranium of the Mammoth has been found, for the first time in this country, near Silsey, Chichester. The specimen was discovered by workmen at a depth of fifteen feet from the surface. The skull must have belonged to an aged individual, for the first pair of molars are not only external, but have been considerably worn in the process of mastication. Of the upper molars eighteen laminæ remain, eleven of which have been used; several of the front laminæ having been worn entirely away. The entire right tusk had been detached, with a portion of the socket, before it had been enveloped in the sands and brick-earth; for, it was found upon the same level in the pit, but at a distance of nearly twenty feet from the cranium to which it belongs. The tusks measure (on the outer curve) 8 feet 8 inches from the apex to the insertion in the socket; the inserted portion measuring about 18 inches.—Vide *Geological Magazine* for November.

New Mammalia from the Red Crag.—Mr. E. Ray Lankester, whose discovery of a new fossil hyæna will be found recorded in our third volume, has announced the discovery of several new species of mammals from the Red Crag. The specimens from an examination of which this gentleman has concluded the presence of several forms new to science, are those in the collection of W. Whincop, Esq., of Woodbridge, Suffolk, and consist mainly of teeth. The following new species have been described (so far as the teeth are concerned) by Mr. Lankester:—*Castor veterior*, *Delphinus uncidens*, *D. orcoides*, and *Canis primigenius*. As an example of the difficulty of identifying strata by the nature of their organic remains, the writer enumerates the following representatives of *nine* different faunæ which present themselves in the Red Crag:—(1.) Upper Greensand fossils in considerable numbers, portions of Ammonites, Terebratulæ, Saurian teeth and bones, &c. (2.) Chalk fossils represented by flints containing Sponges and Echinoderms. (3.) Fossils from the lowest Eocene beds, the Thanet Sands. (4.) Nodules, the so-called "Coprolites," and very numerous remains of fish, crustacea, and (much more rarely) reptiles and mammals derived from the London clay. (5.) The teeth of *Carcharodon heterodon*, and portions of Edaphodon from middle

Eocene beds. (6.) Teeth of *Mastodon angustidens*, *Rhinoceros Schleiermacheri*, *Tapirus priscus*, and others derived from the breaking up of a Miocene deposit of the same age as the Epplesheim strata. (7.) Cetacean remains, consisting of bones and teeth much worn, teeth of *Carcharodon megalodon* and *Oxyrhina* also worn, derived from a previous Pliocene deposit, contemporaneous with the Middle Crag of Antwerp, where these same cetacean remains and sharks' teeth are abundant in an *unworn* state. (8.) Skulls derived from the *Coralline Crag.* (9.) The proper faunæ of the Red Crag, certain fish remains, mollusca, crustacea, and, perhaps, some mammalia.—Vide *The Annals of Natural History*, November.

Flint Weapons beneath the Skull of Rhinoceros hemitœchus!—In M. Lartet's memoir on the ossiferous cave of the Périgord, a serious mis-statement has been made, which in some measure affects the reputation of one of our distinguished geologists, Dr. Falconer. M. Lartet states that in "the cavern of Long Hole several flint weapons were found under the head of this latter Rhinoceros." In a previous passage he alludes to the discovery of certain fossils in this cavern by Messrs. Wood and Falconer, and hence the latter gentleman becomes associated with the assertion. Dr. Falconer now emphatically denies that there were any flint weapons found *beneath* the skull of *R. hemitœchus.* He writes to the editor of *Annals of Natural History* as follows:—"No skull of *R. hemitœchus* above flint knives was ever discovered by my friend and fellow-labourer Col. Wood in Long Hole cave, nor was any skull of that extinct species ever found in it. The flint implements which he found there, together with the immediately associated fossil remains, were at the time transmitted to me for investigation, and out of my hands they have never passed." . . . . "A detached shell of a milk-molar was among the number; hence, probably, the origin of the assertion about the skull—a small milk-molar having been exalted into a skull, found above flint implements, doubtless from inadvertence, misconception, or error of recollection." It would appear that M. Lartet's assertion was founded upon the authority of Sir Charles Lyell, who, strange to say, in his appendix to the third edition of his "Antiquity of Man" asserts that Colonel Wood "detected flint knives beneath the skull of *Rhinoceros hemitœchus.*"

Remains of Plants beneath the Swiss Lake Dwellings.—Professor O. Heer has carefully investigated the specimens of plants found in the above-named locality. The remains discovered at Robenhausen have especially engaged his attention. The remains of cereal plants were as follows:—A small grained variety of *Triticum vulgare* occurs most frequently at Robenhausen, and also at Wangen in the Lake of Constance; a *Triticum vulgare* with grain of the ordinary size is also met with. These two varieties have been sent to the Professor from a locality near Olmütz, the age of which is unknown. Near Robenhausen, *Triticum turgidum* occurs, a species still cultivated in the south of Europe, but scarcely in Switzerland. Of barley, *Hordeum hexastichum* is generally diffused. Its ears, from which the grain has fallen, are found well preserved in most of the lacustrine villages. According to Unger, this barley is also that of the ancient monuments of Egypt, whilst our common barley is wanting in both localities. In all, ten species of cereals were found, and with them abundant remains of straw. The millet cakes found at Robenhausen, and the numerous fragments of round flattened loaves, in which the grains of wheat are still recognisable, furnish conclusive evidence of the mode of preparing food from these cereals. The grain was evidently triturated very imperfectly between plates of stone, and the dough was baked under hot stones and ashes. Three leguminous plants were found; two varieties of the apple, and cherries and plums. Flax was found in large quantity, and immense numbers of strawberries and raspberries.—Vide *Bibliothèque Universelle*, October.

Contents of Skull Mounds at Keiss, in Caithness.—At a meeting of the Anthropological Society, held on Tuesday, December 6th, Mr. Laing read a paper on the organic remains found in a kist near Keiss. In the lowest stratum of the mounds were discovered, mingled with the skulls of limpets and periwinkles (which appear to have constituted the principal articles of food of the people of those times), some bones of oxen, horses, and pigs, and stone implements of the rudest possible kind. In continuing his explorations, Mr. Laing came upon some kists, which consisted of a slap of stone, just large enough to hold the body of a man, and inside, covered with sand, he discovered the skeletons of those who had been interred. Most of them were very short, not being more than 5 feet 4 inches long, and in these kists no implements of any kind were found; but in two instances he discovered kists of a much larger size, in which the skeletons measured 6 feet and 6 feet 4 inches. These were presumed to have been the chiefs of the race; and, buried with one of them, were fifteen stone implements of small size, and of the rudest character, exhibiting a lower degree of art than the flint implements found with the bones of extinct animals in tertiary geological deposits. Mr. Laing regarded some of the skulls as presenting the character of those of Ancient Britons, and others as being of negro type; but Professor Owen, who was present, said that the skulls differed in several essential particulars from the form of the Ethiopian skull: one of them might be mistaken from part of its configuration for that of an Australian, but the small size of the molar teeth showed that it was of a different type. In commenting upon a child's jaw-bone, which Mr. Laing exhibited, the Professor observed that he was well acquainted with the marks made by savages on the jaws of animals they devoured as food, and he feared the evidence which the child's jaw afforded tended to prove that our progenitors, who inhabited Scotland at a remote period, must have been cannibals. The dental cavity is filled with nerve-pulp, which savages relish, and the child's jaw-bone indicated that it had been broken to extract that substance.

The Controversy upon English and Alpine Geology which has been maintained between Mr. Ruskin and Professor Jukes, and which will be found in full in the pages of the *Reader*, is so full of personalities on both sides, and so devoid of the philosophical elements of discussion, that we merely allude to it to prevent our readers giving further attention to the subject in this phase of its development.

The Epochal and Detrital Theory of Geology is somewhat cleverly, though, we think, partially considered in a pamphlet written by some one who signs himself a near kinsman of Thomas Didymus. The question which the author of this *brochure* raises, relates to the supposed derivation of all subsequent deposits from the granite. He is at great pains to show, by a series of chemical calculations, that the granite could not have supplied all the lime which exists in the limestone deposits; and, by similar mode of reasoning, that the deposits of carbon could not have been derived from the primary. He is modest enough to content himself with attacking an existing theory without supplying a substitute, and in this particular he differs from most scientific sceptics. We think, however, that his assumption of the absence of elevation of land in the beginning is utterly unjustifiable, and that his consequent conclusion that the planet's area is increased, is little better than absurd. At all events, his reasoning is exceedingly ingenious, and since he draws attention to phenomena and facts that have been too little investigated in this country, his pamphlet will, if read, be of some service, though not in the direction its author would wish.

The Supply of Fuel in Ireland.—Under this title a very important and lengthy memoir appears from the pen of Mr. H. O'Hara, C.E., in the *Dublin Quarterly Journal of Science* for October. He concludes that the supply of coal in Ireland is far from being exhausted, and that the quantity of peat is larger than is generally believed, and only requires to be worked and prepared on other principles than those now adopted, in order to make a most valuable addition to the national resources.

MEDICAL SCIENCE.

The Structure of the Cerebellum.—So much progress has of late been made in the direction of histology, and so great has been the modification of views universally accepted a few years since, that it becomes necessary to record carefully the observation of all writers upon microscopic anatomy. Among recent contributions to the study of the minute structure of the central nervous system, few are more interesting than the published investigations of M. Luys, who states with regard to the cerebellum:—

1st. That this organ and its dependencies form a sub-system very accurately isolated in the general assemblage of the fibres of the nervous system. It is only by the intervention of the fibres of its peduncles that it enters into combination with the cerebrum, and propagates its action to the grey substance of the corpora striata.

2nd. Its white fibres pass out of the grey cortical substance as clearly defined filaments, and appear to be composed after their origin by the continual addition of prolongation of nerve-cells of various descriptions.

3rd. All the white cerebellar fibres, whatever be their point of emergence, are directed as rays toward a mass of grey substance at the centre of each cerebellar hemisphere to reach the nerve-cells which are there.

4th. From this common centre of convergence these soon pass forwards, in three directions, as series of secondary fibres, true efferent conductors, which go to distribute themselves among the bundles of spinal ascending fibres, and thus as they decrease, little by little, become the origins of the grey peripheral substance of the cerebellum.

5th. All these efferent offsets are intercrossed; they are distributed in the periphery to the opposite side from that in which they originated.

6th. The lowermost efferent fibres, directed from above downwards, and from behind forwards, take a spiral course through the spinal fibres, and are lost in the net-work of cells of the *olivary body* of the opposite side.

7th. The middle efferent fibres are all more or less directed forwards, as curvilinear bundles, and are lost, after being divided into two principal parts (superficial and deep), almost entirely in the regions of the opposite side to that whence they originated.

8th. The superior efferent fibres pass out of the cavity of the *Rhomboidal* bodies as clearly made up bundles.

9th. The superior olivary bodies which, in point of structure, are like the inferior ones, give off a series of secondary fibres, which disperse in all directions.—Vide *Robins's Journal de l'Anatomie, &c.;* and *Medico-Chirurgical Review*, No. LXVIII.

Granular Layer of the Retina in the Whale.—Herr C. Ritter thus describes the structure of this stratum in the nervous expansion of the whale's eye. This layer consists of three kinds of fibres: (*a*) The fibres of the limitans; (*b*) the branchings of the nerve-cells; (*c*) the processes of the rods and bulbs. The fibres of the limitans curve between the cells and form a beautiful network, the meshes of which become larger towards the *ora serrata*, but its framework is fine in the centre, though coarse near the *ora serrata*. In this net-work the processes of the rods, branching out in various directions, converge into greater branches, and finally form those of the cells properly so called. In the centre of the retina the processes of the rods run straight, combine rarely, and often end as wide as they began towards the cell; as they approach the *ora serrata* the processes run more obliquely, combine to a greater extent, and the branches of the cells become proportionally broader. This explains very simply why the granula-layer in the centre of the retina is narrower, and consists of finer fibres. But the name of "granula-layer" is objectionable. Hence Herr Ritter proposes to term it the *outer fibrous layer* in contradistinction to the *inner fibrous nervous layer.*—Vide *Henle & Pfeuffer's Zeitschrift für Rat. Med.*, vol. XXI., part 3.

Therapeutical Value of Opium.—Some time ago a memoir appeared from the pen of M. Claude Bernard, in the pages of the *Comptes Rendus*, upon the subject of the physiological action of the alkaloids of opium. In this the distinguished author set forth certain opinions. These have since been discussed by a less known experimenter, M. Ozanam, who thus sums up the conclusions warranted by the results of his own investigations:—Therapeutically opium consists of three classes of constituents: (*a*) Calmative substance, as *morphine*, *opianine*, and *narceine;* (*b*) excitant substances, as *narcotine* and *thebaine;* (*c*) mixed substances, which are alternately excitant and calmative, as *codeine*. Examined from a point of view relating to "anatomical localization," each element of opium may be said to have, besides a more or less marked general action, a sort of elective affinity for some special division of the nervous system: thus, morphine, opianine, and narcotine affect the hemispheres of the brain; codeine operates upon the cerebellum and rachidian bulbs; thebaine acts upon the superior or cervicodorsal region of the spinal chord, and narceine upon the lumbar portion. From these qualities opium constitutes a most valuable remedy, and whilst each of its remedies would, if taken separately, produce too exciting or depressing effects, when taken in the combined condition, they naturally correct each other—a fact whose importance has not yet been appreciated by practical physicians. —Vide *Comptes Rendus*, LIX., No. 10.

Action of Tobacco upon the System.—This subject, which has for some time given rise to so much controversy, has lately been discussed both in this country and upon the Continent. In France, M. Decaisne addressed the Academy upon the matter, and asserted that the peculiar chloro-anæmic condition of young boys—sons of artizans and farm labourers—is due in a great measure to the influence of tobacco-smoke. At the meeting of the British Association Dr. Richardson offered more temperate comments upon the question. He considers that the use of tobacco is injurious to young persons, less so to people of older growth, and is rather conservative in its operation upon the frame of the aged. The most serious effects are those shown in the diminution of sensation, and in the operation on the retina. "The habit of smoking," says the doctor, "should not be indulged in by females, as it would tend to deteriorate their offspring, and hence affect the strength of the nation."

Electricity as a Means of Cure.—There can be little doubt that galvanism will eventually hold a high position among therapeutic agents, notwithstanding the great discouragement which its advocates have from time to time received at the hands of the majority of the profession. Herr Remak, of Berlin, has been instituting some very interesting experiments on neuralgic patients, with a view to ascertain the really curative effects of electricity. The results arrived at have certainly been surprising, as the following case will show :—Some time ago (May 11th, 1861) a woman, aged 40, applied to Herr Remak under these circumstances : Fifteen months before she had been attacked with complete facial paralysis of the left side, followed by acute pain, anæsthesia of the ramifications of the trigeminal nerve, and very marked diminution of the mental powers. Despite the administration of physic and the application of the process, known as *Faradisation*, for a period of two months, she became worse. The facial muscles were attacked with spasms which were more severe upon the right than on the paralyzed side. The memory was so much impaired that the patient was incapable of describing even the details of her disease. The day after the "constant current" had been allowed to travel through the cervical ganglion of the left sympathetic, there was a decided improvement observed, for the convulsions had in great measure abated. This application of the current was repeated (in the presence of Herr Remak's pupils) three times a week for a period of about three months, and at the end of that period a complete transformation was found to have taken place ; her mental powers were restored, the convulsions had ceased, and the faculty of sensation was recalled.—Vide *Comptes Rendus*, LIX., No. 11.

The Malpighian Tufts of the Kidney have, according to the observations of Mr. B. Wells Richardson, not only one, but two efferent vessels. This gentleman thus confirms the late observations of Beale and Virchow. We are disposed to receive the assertion that the Malpighian body gives out two returning vessels with some doubt, and should like to see the specimen which shows such an unusual state of things. May it not be possible that the second branch is the efferent vessel of a partially uninjected and subjacent tuft, which, owing to the thickness of the section, has the appearance of an origin in the superior tuft ?—See the *Dublin Medical Press*, vol. IX., p. 489.

The Moveable Corpuscles of the Cornea.—If, says Dr. F. Von Recklinghausen, one removes a thin piece of the healthy cornea of the frog, putting it with some aqueous humour under the microscope, so that the membrane of Descemet is uppermost, so that the aqueous humour cannot evaporate, and so that the preparation is not pressed upon, then, after a few minutes, the movement of corpuscles can be perceived, which appear identical with the pus-corpuscles which change their shape. The mode in which these corpuscles move in the cornea shows that spaces exist in the latter, with fluid contents, in which the corpuscles move about. These spaces cannot be produced by the action of the corpuscles, since their movements are too quick, and they must therefore have existed before. We cannot directly perceive these spaces on account of the index of refraction of the fluid contained in them being the same with that of the substance of the cornea. These spaces seem to be cylindrical when they are narrowest, since the corpuscles possess nearly equal thickness and width. But at some places these invisible canals must be either very elastic or change into wider spaces, since the moving corpuscles in some instances change into somewhat opaque broad masses. The system of canals and large spaces, not visible when the cornea is fresh, seems, according to present observation, to communicate with the lacunæ in the substance of the cornea, which lacunæ are occupied by the peculiar star-shaped movable corpuscles.—Vide *Medico-Chirurgical Review*, No. LXVIII.; and *Schmidt's Jahrbücher*, 1864, No. II.

Poisonous Action of Calabar Beans.—The following tabular results are those obtained by the careful inquiries of Mr. Baker Edwards, and published by him in a late number of the *Pharmaceutical Journal*:—

1st. The bean is edible in poisonous quantities, and although slightly rough in its flavour does not appear to excite disgust or alarm when eaten alone, and would be undiscovered when mixed with food.

2nd. The symptoms are not always immediate, nor is vomiting induced except when the dose is excessive; nor would the secondary symptoms—viz., dizziness, faintness, and loss of power in the limbs—excite sufficient alarm to call for medical assistance until life was really in immediate danger.

3rd. The symptoms would scarcely be distinguished from sudden indigestion or English cholera in time to save the life of the patient.

4th. In criminal cases nothing might be detected by the *post-mortem* examination or by chemical analysis to reveal the cause of death.

5th. So insidious a poison should not only be stored, but also handled with great caution, its alcoholic solution or extraction, when introduced into the circulation, acting as a slow but certain poison, and leaving no trace in the body which can be identified by chemical tests in our present knowledge of the drug.

Effects of Aniline on Workmen employed in its Manufacture.—It would appear that the basis of the new tar dyes has a very injurious action on the bodies of those who are constantly engaged in preparing and handling it. According to the statements of Dr. Kreuser, of Stuttgard, the workmen employed in aniline factories are subject to intense bronchitis, which is characterized by violent dry spasmodic cough, and is accompanied by ulcers seated principally on the lower extremities and the scrotum. These ulcers are round, have well-defined and often callous edges, and are covered with thick blackish crusts, while the surrounding parts are swollen and painful.

All the cases observed by this physician were easily cured by simple treatment so soon as the patients were removed from the vapours developed in the manufacture of aniline. By protecting the skin with proper clothing, by inducing cleanly habits, and by improving the ventilation of the manufactory, this peculiar form of bronchitis seems to be removed, except when the wind takes a certain direction.—See *Medico-Chirurgical Review*, for October, 1864.

Action of Mineral Waters on Skin Diseases.—M. Richard, one of the candidates for the French Academy's medico-chirurgical prize, selected the above as the subject of his *thesis*, and from the latter we abstract the following deductions drawn by the author :—

1st. Mineral waters act directly and locally in removing skin diseases, by checking the congestion of the integument.

2nd. They combat rather the altered products of the blood and consequences of skin diseases than the parasites which produce these maladies.

3rd. The operation of mineral waters upon the external integument is not confined to the diseased tissues, but extends also to the healthy ones ; that of compounds of iodine, chlorine, and mercury, such as used in ordinary medicine, on the contrary, is confined to the injured parts, and tends to the elimination of the morbid element.

4th. In certain cases the mineral waters should be administered as internal medicines, their local action being, in such instances, too diffused, and leaving it probable that a return of the malady may take place after its apparent cure. Besides, the cutaneous absorption of medicines is, to say the least, exceedingly problematical.—Vide *Comptes Rendus*, LIX., No. 15.

Electrical Action of Mineral Waters.—A rather original and, we must confess, in our opinion, more ingenious than probable, hypothesis has been started by M. Scoutetten, to account for the influence of spa-waters upon the system. This *savant* attributes the operation of mineral waters to the development of electric currents which act upon the blood and tissues. From an immense series of experiments he has "demonstrated" (?) that all "waters" determine an electric current which passes from the developing medium to traverse the body immersed in it ; thus all spa-waters are negative to the body which is plunged in them, but the intensity of the current varies with the character of the water. The water of rivers has a feeble electric current, but that of purely mineral springs, on the contrary, engenders a very powerful current,—in some instances deflecting the needle of the galvanometer as much as 70°, 80°, or even 90°. It appears that sulphur waters are most energetic in this respect. His more important conclusions may be thus summed up :—

1st. Mineral waters develope all the phenomena of excitation, the latter being due to the electricity developed by their contact with the body.

2nd. They determine a medicinal action which varies according to the nature of the minerals.

3rd. They exert a peculiar local action upon the skin, especially in regard to the production of eruptions.—Vide *Comptes Rendus*, LIX., No. 13.

Blue Organic Colouring Matter in Pus.—A very curious case, in which the matter suppurated contained a lilac colouring matter allied to indigo, has been recorded by Dr. W. B. Herapath. A microscopic examination of the liquid showed the absence of fungi, and from the circumstance that when placed in a closed bottle the liquid lost colour, and regained it on exposure to air, it was evident that some change of oxydation was undergone. This led the Doctor to chemically examine the pus; and, upon treating it with a solution of hypochloride of lime, the colour was as quickly discharged as if indigo had been present. From this Dr. Herapath concludes that either indigo or some substance allied to it was absolutely present in the system of the patient.—Vide *The Chemical News*, October 8th.

METALLURGY AND MINING.

Extraction of Auriferous Silver in the Liquid Way.—Hitherto the difficulty in extracting alloys of gold and silver from ores by the wet method has been the complete separation of the two. This, however, may now be achieved by washing and lixiviating the ore with a concentrated solution of common salt saturated with chlorine, by which both metals will be simultaneously precipitated.—Vide *Mining and Smelting Magazine*, October.

Preservation of Iron in Water.—At a late sitting of the Academy of Sciences M. Becquerel read a paper on the preservation of cast-iron and iron in fresh-water. He had previously shown that when a plate of either material was in contact with a zinc plate, not exceeding the hundredth part of the surface of the former, the intensity of the derived electrical currents on the protected metal (iron) would in sea-water diminish as the distance from the point of contact of the two metals increased; but nevertheless so that the protection afforded by these derived currents would still extend to a considerable distance from the said point of contact. In fresh-water there are fewer divided currents on the surface of the metal, a fact which M. Becquerel attributes to the difference of conductibility of the two liquids, and the degree of chemical action which each exercises on the zinc, since these two circumstances tend both to increase the intensity of the current. M. Becquerel asserts that a pile of 9,837 cannon balls, twelve centimetres in diameter, may be protected from oxydation under water by surrounding it with zinc bands having an aggregate surface of two square metres.—Vidé *Comptes Rendus*, October 31st.

The Cementation of Iron.—The controversy upon this subject is still continued by M. Caron on the one side and M. Margueritte on the other; the former having laid down the theory that in cementation on a large scale iron is always brought into contact with cyanides, which alone possess the power of cementing; the latter endeavouring to prove, on the contrary, that iron may be converted into steel by pure carbon (that is, by either diamond, carbonized sugar, or plumbago), or else by pure carbonic oxide.—Vide *The Artizan*, December.

Copper in Spain has recently been discovered by M. Tribaut, a French mining engineer. This gentleman has found a very rich vein of cobaltiferous copper, containing nearly nine per cent. of oxide of cobalt, near Oviedo, in Spain. We learn that he has entered into an agreement with an English house to take nearly the whole produce of his mines.

Lignite in Turkey.—A large deposit of lignite has been discovered at the Jumonassi station of the Ottoman, Smyrna, and Aiden Railway, thirteen miles from the city of Smyrna. Two other deposits are known and worked near the line; these approach the character of lignitic coal, like that of Chili, but the Jumonassi variety is a pure lignite. It is found in abundance to the depth of five feet, and then water is encountered. It burns freely, and is now under trial in Smyrna. From specimens recently discovered near Ephesus and Azirieh there is strong reason to believe the existence of minerals of lead and antimony in the Ephesus pass, near the great tunnel, and of iron at Azirieh.

Improved Method of Cooling Iron.—In manufacturing cast-iron articles, in which great toughness is required, combined with considerable hardness, Mr. N. M'Haffie, of Glasgow, mixes white pig with mottled or grey pig iron, which if cast in the ordinary manner would be too hard to be conveniently cut and worked. The metal is run into a mould of fire-clay, or other material, which is kept heated to redness, or even higher, and is then gradually cooled down in the furnace. This gradual cooling of the metal insures uniformity of structure throughout the mass, and although the metal is still hard, the article can be afterwards turned or shaped, and if necessary it can also be hardened and tempered in the same way as steel.—Vide *The Mining and Smelting Magazine*, November.

Decomposing Peat by Potash.—This is done by a recent process devised by M. Fleury, of Brussels. The peat is treated with calcined carbonate of potash, by which means the mineral substances and woody fibres are decomposed and dislodged. Both the decomposed and undecomposed peats are converted into heavy fuel, the pulp being compressed and dried in the ordinary manner.

Improved Blasting Powder.—Herr Nobel, of Stockholm, some time since, proposed to increase the effectiveness of ordinary blasting powder by the addition of nitro-glycerine. The latter is a very clear, oily fluid, which ignites at about 170° centigrade, and burns slowly and with a peculiar crackling noise. When added in certain proportions to blasting powder it increases its power to three or four times that which it originally possessed. When proposing the new addition, Herr Nobel little dreamed what the result of his experiment would be. On the 24th of September the works which he had recently erected near Stockholm for the manufacture of this article were totally destroyed by an explosion. Several persons were killed, among them Herr Nobel's son, and many seriously injured.—Vide *Mining and Smelting Magazine*, No. 35.

An ancient Mining Wheel, upwards of 20 feet in diameter, and 11 feet 6 inches breast, has recently been exhibited at the Academy of "Arts et Métiers" at Paris, by M. A. Sanson, who states that it was discovered in a Portuguese mine, and was doubtless employed by the Romans to raise water in the operation of draining the mine. Eight other of these wheels have lately been discovered by the miners, who are now working the same old mines. These wheels are made of wood—the arms and felloes of pine, and the axle and its support of oak, the fabric being remarkable for the lightness of its construction. It is supposed that these wheels cannot be less than 1,450 years old, and yet the wood is in a perfect state of preservation, owing to its immersion in water charged with salts of copper and iron. From their position and construction, these wheels are presumed to have been worked as treadmills, by men standing with naked feet upon one side.—Vide *The Artizan*, November.

MECHANICAL SCIENCE.

Steel Boilers.—In 1859, Herr Köhn, a German engineer, placed in a boiler 40 feet long, and constructed generally of iron plates, 11m.m. (0·429in.) thick, a plate of steel only $5\frac{1}{2}$m.m. (0·215in.) thick. After $2\frac{1}{2}$ years of service, this plate, placed near the furnace, was found to be uninjured, whilst the neighbouring iron plates were much corroded. More important still, the quicker evaporation from the thin steel plate appears to have prevented incrustation.

Cast Iron Boilers.—Mr. Zerah Colburn, C.E., read a paper before the British Association, chiefly to show the superiority of the Harrison boiler[*] over the wrought-iron boilers now generally in use. He points out that taking the tensile strength of wrought-iron plates at its minimum of 16 to 18 tons per square inch, and that of cast-iron at 5 tons, the cast-iron spheres are practically as strong as wrought-iron cylinders of the same thickness. For the strength of the wrought-iron is reduced from 18 tons to 10 tons in consequence of the riveted joints ; and, as the hollow sphere is twice stronger than the hollow cylinder of the same diameter and thickness, the cast-iron, having no joints, becomes equal in this comparison to the wrought-iron plate. Corrosion is the great malady of modern boilers. In the experience of the Manchester Boiler Association with from 1,300 to 1,600 boilers always under their care, one boiler out of every seven, and in some years nearly one out of every four, becomes defective by corrosion alone. On the other hand, the presence of a little carbon, as in cast-iron, renders it nearly indestructible. Hence Mr. Colburn concludes that abundant experience shows that cast-iron may be employed in boilers without the possibility of corrosion. Lastly, Mr. Colburn notes the fact observed in the use of cast-iron spherical boilers, that the scale is spontaneously thrown off as soon as formed, and blown out with the water at the end of the week. None of the iron is removed with the scale, the spheres weighing the same after three years' service as when new.

Strains of Ships.—Professor Macquorn Rankine has communicated to the British Association some calculations on the strains of ships afloat. He supposes the ship supported amidships on a wave crest, and dry at the ends, and finds that the bending action cannot exceed that due to the weight of the ship with a leverage of one-twentieth of her length, and that the racking action cannot exceed about sixteen one-hundredths of her weight. Applying his formulæ to two remarkably good examples, he gets the following results :—

	Iron Ships.	Wooden Ships.
Maximum tension	3·98 tons per square inch.	0·375 tons per square inch.
,, thrust	2·35 ,, ,,	0·293 ,, ,,
,, racking stress	0·975 ,, ,,	

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[*] Vol. IV., page 536.

Gun Cotton.—Mr. Scott Russell read to the British Association the report of the Committee on gun-cotton. It stated that General Hay had constructed a form of cartridge suited to the Whitworth Rifle ; that he found the use of gun-cotton was clean, and did not foul the gun ; that it had much less recoil for the same effect; that one-third is the equivalent weight of charge, and that it does not heat the gun. For driving shafts and tunnels it had been applied in many instances. At Wingeworth Colliery one-thirteenth the weight of gun-cotton, as compared with gunpowder, produced the same effect. At the slate quarries of Llanberis and at Allenheads one-seventh was required. The air was uncontaminated by smoke, and the work could be carried on more rapidly. It had been tried in detaching large masses of rock at Festiniog and Holyhead, and it was found that 1lb. of gun-cotton was able to detach 50 to 60 tons of rock.

On the other hand, MM. Pelouze and Maurey have communicated a memoir to the Academy of Sciences at Paris, chiefly on the chemistry of the subject, but leading to conclusions adverse to its employment. They sum up their results as follows : the question of the employment of gun-cotton in firearms "remains pretty much in the state in which it was left by the French Commission of 1846. Nothing, in fact, justifies our thinking it possible in the present state of our knowledge, either to prevent the spontaneous explosion of gun-cotton, or to correct practically its bursting properties, still retaining the ordnance in use for ordinary powder.

M. Séguier, however, has employed mixtures of gun-cotton, and coarse gunpowder, managing the point of inflammation so that the powder shall be first fired. The projectile, he says, is thus gradually urged onwards in its movement, and its inertia no longer presents a resistance capable of causing the rupture of the barrel by the instantaneous detonation of the cotton.—See *Reader*, Nov. 26, 1864.

Superheated Steam and Feathering Paddles.—Mr. Beardmore has communicated to the Institution of Engineers in Scotland the results of a large number of trials of steamships, before and after the application of superheating apparatus, and in certain cases with the substitution of feathering for ordinary paddles. We have condensed into a tabular form the average results of these trials :—

Steamship.	Without Superheating.		With Superheating.		Percentage of Coal saved.
	Time on Voyage. Hours.	Coals. Tons.	Time on Voyage. Hours.	Coals. Tons.	
Metropolitan	51·33	46·16	51·16	35	23
Berlin	39·3	96·6	40·6*	62·1*	35
Concordia	21·7	20·9	19·5*	12·2*	41
Seine	9·7*	7·4*	9·8*	5·4*	27

The figures given above are the average of from 6 to 10 trials each. Those marked with an asterisk give the result of trials in which feathering paddles were employed.

Hydraulic Press.—In the ordinary hydraulic press the advance of the piston is effected by fluid pumped in. MM. Desgoffe and Ollivier have contrived a press in which the pumps are suppressed. For this purpose the press is provided with a bobbin in the ram chamber, into which a catgut band can be coiled ; this catgut band drawn into the chamber through a stuffing-box, acts in the same way as the fluid pumped in in the ordinary press. The ram chamber is filled with oil.

Influence of Changes of Loads on Wrought Iron Structures.—Mr. Fairbairn has communicated to the Royal Society the results of his experiments on the effects of continued changes of load and vibration on girders and bridges. A wrought-iron plate girder was arranged so that a definite weight, representing a railway train or other moving load, could be placed upon it, removed and replaced successively, the number of changes being registered. Under these conditions the beam sustained 596,790 changes of a load equivalent to one-fourth the breaking weight, and 403,210 changes of a load equal to two-sevenths of the breaking weight. It then broke after 5,175 changes of a load equal to two-fifths of the breaking weight. After being repaired the experiments were repeated, and the beam sustained 3,150,000 changes of a load equivalent to one-fourth the breaking weight, and broke after 313,000 changes of a load equal to one-third of the breaking weight. The tensile strain on the bottom flange, allowing for the metal punched out for rivets, was, in the first trials, 6·25 tons, 7·39 tons, and 9·88 tons respectively, and in the latter trials 6·25 tons and 8·45 tons respectively. From these experiments Mr. Fairbairn infers that a wrought-iron bridge would be safe for a long series of years, with a strain of 6 tons per square inch, or one-fourth the statical breaking weight. It is, however, evident that time is an element in the resisting powers of materials of every description under changing loads.

MICROSCOPY.

Notices of additions to science, which some would arrange under the above head, may be found in the following sections :—

- BOTANY—
  - New British Lichens.
  - The Development of Composite Flowers.
  - Raphides as Diagnostic Characters of Plants.
  - Importance of studying Development of Algæ.
- MEDICAL SCIENCE—
  - The Structure of the Cerebellum.
  - The Retina of the Whale.
  - The Malpighian Tufts of the Kidney.
  - The Moveable Corpuscles of the Cornea.
  - Blue Matter in Pus.
- ZOOLOGY—
  - Are Vibriones Animals ?
  - Peculiar Structures in the Seminal Fluid of Ianthina.
  - Termination of Nerves in Muscles of Insects.
  - The Circulation in the Vorticellidæ.

Little has been done during the past quarter in the manufacture of new forms of instruments, and this result, we apprehend, is attributable to the unwise selection of a season adopted by the Microscopical Society for awarding its prize medals.

A new Form of Mounting Table has been described by T. G. Stokes, who objects to Mr. Goddard's contrivance, upon the ground that there is no provision for regulating the temperature, so as to prevent its rising to the boiling point of Canada balsam. He has for some time employed a water-bath of tin or zinc, 14 in. by 3½ in., and 3½ in. deep, with a ledge running round the top to prevent the slides from slipping. If a cover of cardboard be placed on this to keep off the dust, and the orifice through which the water is introduced left open, the apparatus, with the slides on it, may be left to itself for any reasonable length of time over any source of heat.—See the *Quarterly Journal of Microscopical Science*, December.

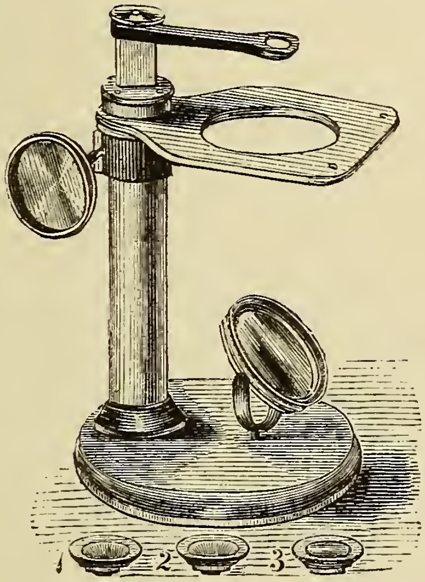
Use of Dyes in Microscopical Investigations.—Some observations of the utmost import have recently been made by Mr. Walter Abbey, M.R.C.S., upon this matter. This gentleman, who differs in opinion from the conclusions at which Dr. Beale has arrived, turned his attention to the study of colours which attract certain portions of tissues and these only. In searching for new dyes, as substitutes for additions to carmine, which is now so much employed, he has discovered a blue tinting solution allied to the aniline compounds, which "has intense and splendid colouring power, and is even more brilliant by artificial light than by daylight. It is also freely soluble in water; thus refuting Dr. Beale's explanation of the limited dyeing power of carmine, which he attributes to the acid reaction of the 'germinal matter' upon the alkaline solution of the dye." Mr. Abbey, by experimenting with various colouring matters, has been enabled to separate the secondary layers of the vegetable cell from both the cell-wall and the nucleus. He enumerates the following conclusions, which differ very materially from those of Dr. Beale :—

1. The germinal matter, so called, consists of two parts—the one dyed by carmine, the other not so.
2. It is not possible by means of tinting agents to demonstrate the gradual transition of living matter into dead matter.
3. The varying tints of the dyed nucleus are due to the greater or less dispersion of the coloured molecules through the uncoloured substance, their close aggregation forming the nucleolus.
4. The uncoloured portion of the germinal matter is the product of the coloured portion.
5. Nutrition is least active in the most deeply-coloured part of the "germinal matter."

Mr. Abbey suggests the employment of a new set of expressions, which, however, we regard as being more ill-timed than those of Dr. Beale. We do not bind ourselves to a faith in the doctrines of either, and we hold that the question of development of tissues is even yet in an unworked condition.—See for Mr. Abbey's paper, the *Microscopical Journal*, vol. IV., p. 269.

A Cheap Form of Dissecting Microscope, which is represented in the annexed woodcut, has been constructed by Messrs. Baker, opticians, of Holborn. This instrument, which commends itself to all working histologists, consists of a solid circular foot of brass, from the border of which arises a firm leg, supporting the stage—which is of ample dimensions—and the body.

The latter, to which is attached a firm horizontal bar, into which the lenses are screwed, is elevated and depressed by a rack-and-pinion movement, the milled head being situate at a level a little below that of the stage. In the centre of the foot is placed the mirror, which moves in an arc of brass, that in its turn works upon a pivot in the foot of the instrument. This microscope, with three lenses and mahogany case, is (we understand) sold at the moderate price of thirty-five shillings.



BAKER'S DISSECTING MICROSCOPE

MINERALOGY.

Very little has been added to our knowledge of this subject during the past quarter. A good deal has been achieved in the shape of compilation, and under this category we would class Professor Sterry Hunt's memoir on "Contributions to Lithology," in the new Series of the *Canadian Naturalist and Geologist*. The following account, however, of a new mineral, may interest our readers.

Tasmanite, a New Mineral of Organic Origin.—This mineral is described by Professor Church in the *Philosophical Magazine*, for December, and in the *Chemical News*, of December 10, and from the latter we take the description of the new compound. It occurs in laminated shale, near the river Mersey, north side of Australia. The shale contains from 30 to 40 per cent. of a yellowish brown combustible matter, which occurs in small disks marked with a few ridges. These disks may be separated from the inorganic portion of the mineral by crushing it to coarse powder and pouring strong hydrochloric acid over it, when the disks become liberated, and float to the surface of the liquid, the density of which should have been increased by the addition of chloride of calcium to it. The density of the disks is about 1·18 ; hardness, 2 ; fracture conchoidal ; and lustre resinous. They are unaffected by hydrochloric acid, uncarbonized by sulphuric acid, and slowly dissolved by nitric acid. They are insoluble in alkalies and in ether, bisulphide of carbon, alcohol, benzole, and other similar liquids. When submitted to distillation, *tasmanite* gives oily and solid products. The most marked character of the new mineral is the quantity of sulphur it contains, not in combination with a metal, as in pyritic coal, but in intimate union with the carbon and hydrogen of the organic matter itself. It has the following composition:—

Carbon	79·34
Hydrogen	10·41
Sulphur	5·32
Oxygen	4·93
	100·000

It is regarded as being the sulphide of an oxidised radical homologous with benzole.

PHOTOGRAPHY.

A New Process.—The *Times*, the *Art Journal*, and other of our non-scientific contemporaries, recently sounded a trumpet blast in the ears of the public, announcing a certain wonderful new photographic process, by which, salts of uranium being substituted for nitrate of silver, no more faded photographs were to be known, as everybody henceforth would patronize the new "United Association of Photography," by which this marvellous improvement had been purchased and patented. Since the publication of the specifications, however, it turns out not only that there is nothing new in the process, but also nothing true in the startling assertions made in its behalf. The uranic salts being used *with the nitrate of silver*, and the former only being removed by the liberal washing, and weak acid solution used for fixing, it follows that the various chemical combinations formed, and which are still sensitive to light, must remain in the print; and, consequently, so far from these productions being more permanent, they must positively be less permanent than photographs produced in the ordinary way now in vogue. With regard to the novelty of this process, most photographic readers know that it was originally published by Mr. Burnett through the photographic journals in 1857; that it was afterwards described by M. de la Blanchere before the *Académie des Sciences* of Paris, and that a provisional specification, dating February 27th, 1858, embodying the discoveries of Mr. Burnett, was entered by a Mr. William Clarke. Putting aside, however, the claim of Herr Wolhly's discovery, in regard to its patent rights and the bad taste which set it afloat under false colours, the pictures it produces are very charming, and means should be at once sought for giving them a more just claim to be considered permanent. The "Wolhly-type process," as it is called, is thus described: A good sample of photographic paper is prepared in the usual way with albumen, arrow-root, common starch, of some simple material similar in character, which is afterwards forced into the texture of the paper, either by pressure or friction, so as to form a very hard, smooth, and even surface. Instead of sensitizing with nitrate of silver alone in the ordinary way, a collodion is prepared, containing a little gum to increase its flexibility and adhesiveness, and having from one to three ounces of nitrate of uranium added to every pound. This is poured over the paper, which is next floated as usual, and when dry is ready for the printing frame. When printed it is "fixed" (?) in a bath of acetic acid, in which it should remain some ten or twelve minutes, and it is afterwards placed on a sheet of plate glass and thoroughly washed under a stream of water with the aid of a sponge or brush.

Another New Process.—Another process, with a somewhat more legitimate claim to novelty, perhaps, and which produces pictures surpassing in artistic delicacy, brilliancy, and beauty of detail and finish all we have seen, has been even more recently described in the pages of the *British Journal of Photography.* This is called the "Toovy-type process," and is thus carried out: A piece of white opal glass, the surface of which has been ground perfectly smooth, is first coated with albumen. To prepare the albumen for this purpose thirty grains of chloride of ammonium, or sodium, are added to the whites of three fresh eggs in a perfectly clean ten-ounce bottle. To render this more limpid and homogeneous, three or four drops of strong ammonium are added to the mixture, which is then violently shaken until the whole is beaten into a froth. After standing for twenty-four hours the albumen thus prepared is filtered through two or three folds of muslin, and is ready for use. The ground surface of your aforesaid glass being washed under a tap in running water, and rubbed with, say, an old tooth or nail brush, *thoroughly freed from soap*, is next dried and coated with the albumen. The latter process is aided with a glass rod or camel-hair brush; air bubbles and particles of dust must be carefully avoided. When covered the plate should be tilted over the bottle so as to allow the superfluous albumen to flow back, and the plate moved in the same way as is done when coating a glass with collodion. After draining it is put carefully aside to dry *spontaneously*, and when this is accomplished it is sensitized in the ordinary way in a silver bath, which has just previously been filtered. In this bath it should remain about two minutes, and when that time has expired it should be allowed to dry, *spontaneously*, in the dark. After being printed on from a negative in the ordinary way, it is next taken from the pressure frame, washed, and toned in the usual alkaline gold-toning bath, and fixed, just as common silver prints on paper are, in a *strong* bath of hyposulphate of soda. Then, being washed and dried, the print is finished, and will be recognized as one of the most pleasing and attractive specimens of this wonderful new art.

The Dublin Exhibition.—Active exertions are being made in various quarters, official and photographic, to secure an unusually creditable display of photographic art at the Dublin International Exhibition, which is to be opened in May, 1865. The committee entrusted with the management of this department announce the fine art claims of photography as thoroughly recognized, and describe a system of classification very superior to that adopted by the Commissioners of 1862.

New Lens.—An optician in Philadelphia has recently introduced a new lens, for which he claims many qualities of no small importance, viz., a flat field, wide aperture, and unusual clearness and sharpness in the images produced. It consists of two achromatic lenses, one 2¼ inches in diameter, with a focus of 4½ inches; the other, an achromatic negative lens, similar in construction to that of the well-known orthoscopic combination. If the claims advanced are well founded, this new lens will be a welcome addition to our photographic appliances.

Improved Method of Testing for Lime-toning Baths.—At a recent meeting of the South London Photographic Society—one of the most enterprising and active of the numerous kindred societies—Mr. F. W. Hart described a method of preparing test paper, to aid in securing uniformity in the lime-toning baths, which has been signally successful. This description runs as follows :—First make a solution of ten grains of iodide of potassium in ten ounces of water, then make twenty-five grains of Glenfield starch into a stiff paste with a few drops of cold water, and add to it ten ounces of boiling water. These two solutions are then mixed and poured into a clean porcelain bath. Immerse the paper, remove, dry, and preserve it from the air. By using this the perplexing questions arising from the various qualities of different samples of lime, &c., may be avoided. If the chlorine solution prepared in its full quantity be tested, the paper will indicate its proper condition by turning a faint bluish gray ; while if it assume a decidedly blue colour, too much lime is present. Such is the delicacy of this test that the paper will readily demonstrate the presence of even one drop in ten thousand.

Strong Negatives from Weak Ones.—The *Bulletin Belge de la Photographie* gives the following process of obtaining a strong negative from one so weak as to be in itself useless for the purpose of printing. The weak negative is placed in *a camera with conjugate foci*, a proof of it is obtained and developed with pyrogallic acid. The same acid with a little silver is used to give it intensity. A transparent positive of greater strength than the original negative is thus obtained, which, being placed in the back frame of the camera with conjugate foci, and again copied, gives a negative from which, when developed and fixed, positives on paper may be readily obtained.

A New Printing System.—Mr. Swan, of Newcastle, whose carbon process we have described in these pages, is engaged in perfecting a new system of printing, based upon the well-known mode of obtaining an image in relief by the use of gelatine, subjected, first, to the action of light under a negative, and secondly, to that of water. The image so obtained has the lights depressed and the darkened portions of the image raised. From this an electrotype is obtained in which the raised and depressed portions are, of course, reversed. This electrotype is next treated with a thick solution of gelatine containing Indian ink, and when this is slightly set it is printed from in the same way as from an ordinary copper-plate, by contact and pressure. It is evident that the darkened gelatine will adhere to the paper, and be removed from the intaglio or mould with it, when, being dark in degrees proportionate to its thickness, as regulated by the depth of the depressed surfaces, it will form an image in appearance precisely similar to that of Mr. Swan's other beautiful carbon prints, but possessing many advantages in escaping the danger of cracking, &c., due to the character of the surface of collodion and gelatine required for the production of the latter, and in the superior speed, certainty, and cheapness of the former's production. This is a most important and promising step, which we hail with considerable pleasure and hope.

Dr. Duchenne's Auto-Photographic Process.—M. Duchenne, of Boulogne, long since conceived the idea of representing photographically microscopic studies of the nervous system, so as to compare the normal with the pathological condition. After many attempts, dating back some years, a considerable amount of success has been obtained, as was proved by the specimens of the process recently presented to the Académie des Sciences. Dr. Duchenne's paper (condensed) says :—" The plates which I now present to the Académie show, in comparison with the normal state, the microscopic anatomo-pathology of the spinal roots in the progressive locomotive ataxy. The great number of the figures, when compared with the original microscopic preparations, show that they are rendered with that exactitude which the hand of man could but rarely equal. The price of printing each plate will not exceed six centimes. If we consider that these figures are not changeable, like those produced by photographic printing, we shall comprehend how much photo-autography, applied to microscopic works, interests the progress of science. The process employed is similar to that of Colonel James in England. A positive is printed upon bichromated gum or gelatine paper, and covered with a greasy ink, which only adheres to such portions of the print as are insoluble after washing, which is a delicate operation, requiring frequent repetition and considerable experience and care. This is then transferred, as in ordinary autography, to a metallic plate or prepared stone, into the body of which it penetrates without the interposition of any foreign body. From this 1,500 or more excellent proofs may be obtained." The process, however, to which Dr. Duchenne owes his ultimate success is that of Captain Bau, a French gentleman, attached to the staff of the Minister of War, and which is thus described :—

1st. Cover the surface of a zinc plate or lithographic stone with a thin film of bichromate of potassa mixed with sufficient sugar-candy to give a smooth polished surface.

2nd. Expose under a positive so as to obtain a negative.

3rd. Wash away with a sponge, lightly applied, to remove the soluble or dark portions of the bichromate (those not exposed to the light's action).

4th. Apply lithographic ink, which enters deeply into the bare portions of the surface and covers the blackened parts ; then clean the surface as with an engraving.

5th. Dissolve the exposed bichromate with water slightly acidulated, which will not disturb the lithographic ink.

6th. Wash well under a tap with running water so as to carry off the bichromate of potassa and leave only the design in greasy ink, which has penetrated into the substance of the stone.

The plate is afterwards submitted to the usual lithographic treatment.

The Use of Cyanide of Potassium.—So many accidents have occurred, and do continually occur, through the use of this dangerous chemical, some of which have been fatal, and all of which must be serious, that it may be as well to remind those photographers who have been in the habit of using it to cleanse their hands from silver stains, that if they promptly wash them in water, using a piece of pumice stone, such a highly objectionable process of cleansing need not be adopted.

Astronomical Photography.—M. Faye, in some memoirs presented to the Paris Académie des Sciences, endeavours to point out some errors which the present system of observation produces in the astronomical determination of the hour, and shows that the only remedy against such is to be found in the adoption of electric telegraphy and photography. M. Faye says " The possibility of dispensing with the observer has been fully shown at Paris, for some years past, by the experiments made by M. Poiro, at my suggestion, in his ateliers, with the assistance of MM. H. Robert, Digney Frères, and Juinet.

"The process, which is extremely simple when operating with the sun, becomes more delicate, but not impracticable, when applied to the stars. It consists in substituting a photographic plate for the eye of the observer, and to register electrically the instant when the light is admitted into the camera applied to the meridian telescope." We have thus obtained ten observations of the sun in twenty seconds. When I say we have obtained, it would be more correct to say that we thought of making an impromptu astronomer of a boy, who was simply charged with drawing a shutter and moving a spring, a task which might have been performed by a machine. If astronomers who have already separately adopted these two powerful means of observation, conclude, as I hope they will, by adopting the still more powerful combination, I desire that the Académie may be reminded that I had the honour of presenting to it, some five or six years ago, the first effectual observation of an eclipse completely registered by means of this combination of electricity and photography, and the first meridian observation of the sun, independent of the senses of the human brain.*

"While examining recently the negative of this curious observation, which I have carefully preserved, I remarked certain defects which I had not noticed before, and upon examining it more closely, I recognized that these defects were inherent, not in the proof, but in the sun itself. They are, in fact, solar spots which have described themselves at the same time as the edges of the disk to which the attention of the observer should be directed. Here, then, is an automatic observation which gives with great exactness, not only the situation of the orb at the moment of the true southing, but also that of its spots, the study of which has assumed so great an importance of late years.

"Here, then, is a fresh example of the superiority of automatic observation over the old method, based upon our senses ; as a general rule, we see only those things which interest us at the moment of observation, and the rest almost always escapes pre-engaged attention. Automatic observation, on the contrary, registers everything which we seek now and which we look for afterwards.

"It has been objected that the complication this system will introduce into the daily practice of our observatories will provoke much opposition ; to this I reply, that we must pay the same price for every increase of precision in the celestial measurements ; for an observatory of the nineteenth century differs even more from the early observatories, than the machinery of our mills differs from the old spinning-wheel. We shall make fewer observations, but these few will be more reliable. A recent instance has shown to astronomers how unsafe it is to boast of apparent exactness. It is well established nowa-days that the distance of the earth from the sun, accepted till recently by all astronomers as a definite datum, included an error of more than onethirtieth of its value. We must expect other mistakes of this kind so long as we allow causes of error to exist in the domain of observation, which escape all analysis, like the physiological cause which I now introduce to the notice of the Académie."

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* "By this I mean negatives obtained upon a large scale, with the indication necessary to refer the measure to the celestial circles."

PHYSICS.

Laws regulating the Formation of Drops.—Those of our readers interested in the physics of drops have already read our abstracts of Mr. Tomlinson's valuable papers upon this subject. A rival has now appeared in the field, in the form of the Professor of Chemistry in the Royal College, Mauritius, Mr. Guthrie. This gentleman has commenced his views in a memoir lately presented to the Royal Society, and the following are a few of the more important conclusions which he has drawn. The size of a drop may be influenced by the subjoined conditions :—

(1.) The self-attraction and cohesion of the drop-generating liquid.

(2.) Its adhesion to the matter upon which the drop is formed.

(3.) The shape of the matter from which the drop moves.

(4.) The physical relation of the medium through which the drop moves—on the one hand, to the liquid of which the drop is formed, and on the other to the matter on which it is formed.

(5.) The attraction of the earth upon the drop-forming liquid and upon the medium, as influenced by their respective and relative densities, and by variation in the attracting power of the earth.

When a drop is formed by a liquid falling intermittently through a gas, the following are the laws which control its bulk :—

(1.) The drop-size depends upon the rate of dropping. Generally, the quicker the succession of the drops the greater is the drop—the slower the rate, the more strictly is this the case. This law depends upon the difference at different rates of the thickness of the film from which the drop falls.

(2.) The drop-size depends upon the nature and quantity of the solid which the dropping liquid holds in solution. If the liquid stands in no chemical relation to the solid, in general, the drop-size diminishes as the quantity of solid contained in the liquid increases. The cause of this seems to be that the stubborn cohesion of the liquid is diminished by the solid in solution. When one or more combinations between the liquid and the solid are possible, then the drop-size depends upon indeterminate data.

(3.) The drop-size depends upon the chemical nature of the dropping liquid, and little or nothing upon its density. Of all liquids examined, water has the greatest, and acetic acid the least drop-size. Butyric acid, which has sensibly the same specific gravity as water, gives rise to a drop less than half the size of the water drop.

(4.) The drop-size depends upon the geometric relation between the solid and the liquid. If the solid be spherical, the largest drops fall from the largest spheres. Absolute difference in radii takes a greater effect upon drops formed from smaller than upon those formed from larger spheres. In fact, the drop increases in size according as the radius of the sphere increases from which the drop falls. And since the difference from this cause may amount to half the largest drop-size, it is worthy of the consideration of the dispensers of medicine. The lip of a bottle is sensibly annuloid. The amount of solid in contact with the dropping liquid is determined by the size of two diameters, one measuring the thickness of the rim of the neck, the other the width of that rim itself.

(5.) The drop-size depends upon the chemical nature of the solid from which the drop falls, and little or nothing upon its density. Of all the solids examined, antimony delivers the smallest and tin the largest drops.

(6.) The drop-size depends upon temperature. Generally, the higher the temperature the smaller the drop. With water the effect of a change of temperature of 20° to 30° centigrade is very small.

(7.) The nature or tension of the gaseous medium has little or no effect upon the drop-size.

The Flow of Solid Bodies submitted to great Pressure.—M. Tresca lately communicated a very interesting paper under the above title to the French Academy. The writer's conclusions are particularly interesting, as bearing upon the celebrated theory of the cause of the motion of glaciers, which was put forward some years since by Forbes. The hypothesis to which we refer was based upon the supposition that in glaciers the particles of ice are not so firmly united together as is generally believed, but have the power of flowing over each other. On this view Forbes regarded the motion of an icy sea not as simply the sliding of the entire mass through a valley, but as the movement of a great mass of particles, which have not only travelled over the land beneath, but over each other also; in fact, that a glacier was a very slow-flowing river, in which, as in a stream of water, the particles in the centre flowed more rapidly than those lying next the bank. It seemed hard to conceive that a substance, whose particles possess such an intense cohesive power as those of ice, could be capable of flowing in the manner indicated; but the researches of M. Tresca show that even in metals the same phenomena appear. The result of numerous experiments proved to him that, without undergoing any alteration of state, solid bodies flow from an orifice in exactly the same manner as liquids when sufficient pressure is applied to them. The soft metals were those principally experimented on, and from repeated observations, M. Tresca concludes that there is a unity of constitution in all matter, and that *masses of the most solid metals are formed of separate and mobile particles.*—Vide *Comptes Rendus*, LIX., No. 19, p. 754.

The Spectra of some of the Nebulæ.—The most startling announcement which has been made by science for some years is that which is contained in the results of Messrs. Huggins and Miller's examination of the light of the nebulæ. In a former paper these gentlemen demonstrated by spectral analysis the similarity of constitution between our sun and the fixed stars. In the last communication they stated the results of their examination of the nebulæ, and their arrival at a very different conclusion from that stated in their former paper. The first nebula was in Draco, 37 H. IV. The light of this nebula, unlike that of any other ex-terrestrial body hitherto examined, was not composed of light of different refrangibility, and hence was incapable of forming a spectrum. A greater part was monochromatic, and after passing through the prisms remained concentrated in a bright light which occupied in the instrument the portion of that part of the spectrum to which it corresponds in refrangibility. A more careful examination with a narrower slit showed that, a little more refrangible than the bright line, and separated from it by a dark interval, a narrower and much fainter line occurs. Beyond this again, at about three times the distance of the second line, a third exceedingly faint line was seen. The position of these lines in the spectrum was determined by a simultaneous comparison of them with the spectrum of the induction spark, taken from electrodes of magnesium. The strongest line corresponds in position with the brightest of the air lines; this line is due to nitrogen, and occurs in the spectrum about midway between *b* and F of the solar spectrum. The faintest of the lines in the spectrum agrees in position with the line of hydrogen corresponding to Fraunhofer's F. The other bright line was compared with the strong line of Barium 2,075; this line being, however, a little more refrangible than that belonging to the nebula. Besides these lines an exceedingly faint spectrum was just perceived for a short distance on both sides of the group of bright lines. This the authors suspect to be not uniform, but crossed with dark spaces. This faint spectrum they attribute to the solid or liquid matter of the nucleus, and as being quite distinct from the bright lines into which nearly the whole of the light from the nebula is resolved. The conclusion at which these physicists arrive from the above observations is, that the nebulæ in question can no longer be regarded as clusters of suns similar in constitution to the centre of our planetary system, but as objects having quite a different and peculiar composition. Instead of being considered bodies having a solid nucleus, three nebulæ must now be regarded as enormous masses of luminous gas or vapour; for it is alone from matter in the gaseous state that light consisting of definite refrangibilities only (as in the case with those nebulæ) is known to be emitted. The gaseous matter would seem to be composed of these elements—nitrogen, hydrogen, and a substance unknown. With the exception of nitrogen, the writers state that not one of the thirty elements, the spectra of which have been measured, has a strong line very near the bright line of the nebulæ. If, however, this line were due to nitrogen, other lines should be seen, for there are specially two strong double lines in the spectrum of nitrogen, one at least of which, if it existed in the light of the nebulæ, would easily be seen. This exceptional appearance Messrs. Huggins and Miller explain upon the supposition that possibly the single line may indicate a form of matter more elementary than nitrogen which our analyses have not yet enabled us to reach. The generalization which these gentlemen have formed is based upon the most careful and unquestionable investigations, and appears to be in some measure corroborative of what it has been customary till now to term the wild speculations of Laplace.—Vide *Report of Messrs. Huggins and Miller in The Chemical News*, Nov. 26th.

Relation between Electrical Intensity and Surface.—Sir W. Snow Harris, F.R.S., has done good service to the department of electricity, by publishing the various laws, the formulation of which, from his numerous observations, was given in his memoir, presented some time since to the Royal Society. His remarks upon the complex question of the relation of intensity to surface, are of decided interest. If (he says) three or more separated equal spheres be charged with three or more equal quantities of electricity, and be placed each in separate connexion with the electrometer, the intensity of the whole will not be greater than the intensity of one of the parts. A similar result ensues in charging any united number of similar and equal electrical jars. A battery of five equal and similar jars, for example, charged with a given quantity = 1, has the same intensity as a battery of ten equal and similar jars, charged with a quantity = 2; so that the intensity of the ten jars taken together is no greater than the intensity of one of the jars taken singly. In accumulating a double quantity upon a given surface divided into two equal and separate parts, the boundaries of each being the same, the intensity varies inversely as the square of the surface. Hence two separate equal parts can receive, taken together under the same electrometer indication, twice the quantity which either can receive alone, in which case the charge varies with the surface. Thus, if a given quantity be disposed upon two equal and similar jars, instead of upon one of the jars only, the intensity upon the two jars will only be one-fourth the intensity of one of them, since the intensity in this case varies inversely as the square of the surface, while the quantity upon the two jars, under the same electrometer indication, will be double the quantity upon one of them only; in which case the charge varies with the surface, the intensity being constant. If, therefore, as the number of equal and similar jars is increased, the quantity be also increased, the intensity will remain the same, and the charge will increase with the number of jars.

Crystallogenic Force. — Some observations concerning the phenomena displayed in the formation of crystals were pointed out by M. Kuhlmann to the French Academy at its meeting on October 17th. This chemist experimented upon crystals of sulphates formed on glass, and from solutions which were thickened with gum. There was considerable difficulty in preserving crystals prepared in this manner for the purposes of examination and comparison. Hence the experimenter resorted to photographs and reproductions by means of the galvano-plastic method. By these means exact representations were obtained. The only result of the faintest importance to which these inquiries lead is one which might easily have been anticipated—viz., that no two crystallizations can be obtained exactly alike.—See *Comptes Rendus*, LIX., No. 16.

Conditions under which Air is carried down by a Stream of Water.—Mr. Rodwell, who contributed to a late number of the *Philosophical Magazine* a paper on the *trompe*, a hydro-pneumatic engine much in vogue upon the Continent, describes and enumerates the modes by which air can be carried down by a stream of water falling through a tube. These are four in number:—

1st. If the area of the cross section of the tube through which the water falls be not much greater than that of the orifice through which the water flows, disks will be formed in the tube, and, being pushed down by the descending stream, will force down the air beneath them.

2nd. If the area of the cross section of the tube through which the water falls be much greater than that of the orifice from which the water flows, so that disk action is prevented; or if the pressure on the lower end of the tube be competent to support a column of water in the tube, at such a distance from the orifice from which the water flows that the descending stream has not widened sufficiently to allow of the formation of disks, air will be carried beneath the water-surface, on account of the formation of cavities, according to the theory of Magnus.

3rd. If there is not a great depth of water in the vessel which supplies the descending stream, or if (the depth not of necessity being small) rotatory motion is from any cause imparted to the water, air will enter through a cavity formed above the orifice from which the descending stream issues, and extending into the descending stream.

4th. If the area of the cross section of the orifice from which the water flows be as great, or nearly as great as that of the tube through which the water falls, and if, at the same time, the orifices for the admission of air do not exceed a certain area compared with that of the orifice from which the water flows, air will enter at the rupture of the stream produced at the orifices by the accelerated motion of the water below those orifices.

An Improved Form of Colour-top.—Mr. E. Swift, jun., of Liverpool, has transmitted to us the following description of a novel variety of this philosophical toy:—

"A very interesting optical instrument may easily be made by attaching to the colour-top known as Gorham's a simple arrangement of frictional wheels, to give to the disks a velocity with ease of from two to three thousand revolutions in a minute.

"In the one I have had in use for the last three years the two large wheels are 12 inches, the second wheel 4 inches, and the small wheel to which the spindle is fastened 1 inch in diameter. The coloured disks are 10 inches in diameter.

"Fastened to the box containing the wheels is a gas-pipe with two burners at each end, and a small branch pipe to convey the gas to the instrument by means of a flexible tube attached to it. The lights must be placed on exactly opposite sides of the disks. Shades made of tin or cardboard must be placed over the lights, which, though allowing the brightest illumination of the coloured disks, will entirely screen the light from the upper black disks.

"This arrangement gives a very great increase of brilliancy and purity to the colours by artificial light, and if made on a large scale and illuminated with the oxy-hydrogen or electric light, would form a beautiful instrument for public exhibition."

ZOOLOGY AND COMPARATIVE ANATOMY.

Museums and their Uses.—The president of the zoological section of the British Association, Dr. J. E. Gray, diverged from the course usually adopted in delivering his opening address to the Bath meeting. Instead of simply giving a compiled and sketchy account of the progress of zoology during the previous year, he adopted another and a far more useful and practical plan: he read the section a lecture upon the subject of museums and their uses. This address he has since published in pamphlet form, and on that account it comes before us for special notice. The writer is entirely opposed to the present system of arrangement pursued in natural history museums, which he does not scruple to observe are in many cases little better than huge "curiosity shops." The purposes for which a museum is established are twofold. First, the diffusion of instruction and the means of rational amusement among the people ; and secondly, to afford the scientific student every possible opportunity of examining and studying the specimens which the museum contains. Dr. Gray is of opinion that, in the desire to combine these two objects, which are essentially distinct, "the first one—namely, the general instruction of the people—has been, to a great extent, lost sight of, and sacrificed to the second, without any corresponding advantage to the latter." What the ordinary visitants to a museum require is an arrangement which sets forward prominently the typical species of each group, so that, as it were, *he that runs may read.* But this condition is not presented by the modern museum, which "is only to be compared to a large store or a City warehouse, in which every specimen that can be collected is arranged in its proper case and on its proper shelf, so that it may be found when wanted ; but the uninformed mind derives little instruction from the contemplation of its stores, while the student of nature requires a far more careful examination of them than is possible under such a system of arrangement, to derive any advantage." After pointing out the fact that the more delicate specimens are invariably injured, and in some instances entirely destroyed, by exposure to light, Dr. Gray goes on to suggest that, "for the purposes of scientific study, the most complete collection that could possibly be formed would be best kept in cabinets or boxes, from which light and dust would be excluded, in rooms especially devoted to the purpose, and not in galleries open to the general public." This having been done, it would then be easy to present the typical species to the public under such conditions as to interest the merely curious observer, and convey instruction of a general character to those more earnestly interested in natural history. The writer advocates the arrangement of each series of species in a separate case, "but instead of each case, as of old, containing only a single specimen, it should embrace a series of specimens, selected and arranged so as to present a special object for study ; and thus any visitor, looking at a single case only, and taking the trouble to understand it, would carry away a distinct portion of knowledge, such as, in the present state of our arrangements, could only be obtained by the examination and comparison of specimens distributed through distant parts of the collection." According to Dr. Gray's scheme the cases would be arranged to show :—(1.) The classes of the animal kingdom, by means of one or more typical examples of each class. (2.) The orders of each class. (3.) The families of each order. (4.) Genera of each family. (5.) The sections of each genus. (6.) A selection of a specimen of each of the more important or striking species of each genus or section. (7.) The changes of state, sexes, habits, and manners of a well-known or an otherwise interesting species. (8.) The economic uses to which they are applied ; and such other particulars as the judgment and talent of the curator would select, as best adapted for popular instruction.

Dr. Gray concludes this portion of his address by remarking that by carrying out his suggestion "the general public would infinitely better understand, and consequently more justly appreciate, a well-chosen and well-exhibited selection of a limited number of specimens, carefully arranged to exhibit special objects of general interest, than *miles* of glass cases containing thousands upon thousands of specimens, all exhibited in a uniform manner and placed like soldiers at a review."

Are Vibriones Animals?—This question has been lately answered in the negative. M. Davaine, with whose beautiful memoir on the development of the oyster every naturalist is familiar, has turned his attention to the subject of the characters of *vibriones.* He states that these organisms are not to be considered as belonging to the *Protozoa*, or lowest division of the animal kingdom. These beings have no organisation connected with either locomotion or digestion. They are perfectly homogeneous throughout; their two extremities are so much alike that it is impossible to distinguish head from tail, and their progression is effected indifferently by either end of the body, showing that there is no functional distinction between the two. From their different characters it is evident that the *vibriones* approach the filamentous confervæ, and this relation is furthermore borne out by their chemical composition. M. Davaine operated on them with various reagents, and invariably obtained the same results as when he experimented on confervæ dedeveloped in the same medium as the *vibriones.* The essential peculiarity of the latter, therefore, as distinguished from the confervæ, is the power of locomotion, but there is no proof of their animality, inasmuch as the diatomacea and many other of the lower vegetables possess this property. M. Davaine has also found that individuals structurally alike were, nevertheless, physiologically different, and lived in different media. This fact, however, was pointed out before the appearance of M. Davaine's paper by Mr. Henry J. Slack, F.G.S., a gentleman well known for his pursuit of microscopical studies.—*See* for M. Davaine's memoir, *Comptes Rendus*, October 10th.

The Variation of Species.—A rather interesting paper upon the "Introduction of Species" was read, last season, before the Natural History Society of Halifax, Nova Scotia, by Dr. Gilpin. His remarks were chiefly confined to a description of the species of wild horse inhabiting Sable Island, on the south-east coast of Nova Scotia. These horses were originally introduced from England some hundred and fifty years ago, and as they have been affected by the natural condition of life, they have reproduced the wild horses from which our ordinary horses were derived, and this the writer of the memoir considers to be an argument against the Darwinian theory. Without pausing to show how feeble is the foundation which such an objection possesses, we give the writer's conclusion, which is pretty nearly as follows:—The present race of horses in this island has descended from two or three individuals originally introduced, which having been left to themselves, and having followed the laws of natural selection, have produced offspring, having the habits and manners of the *tarpany*, or only stock of wild horses now existing in the world. In regard to their form they differ in some respects from the *tarpany*, though agreeing with them in size, hairy head, and thick coat. But, although differing from them, they have in a wonderful manner, reproduced forms of whose early existence we only know from the sculptures of Nineveh and the friezes of the Parthenon, where we find the low stature contrasted by the tall rider, the abundant tail and mane either cropped or tied and plaited to prevent its encumbering the rider, the hairy jowl, the horizontal head, the short and cock-thrappled neck, and in some figures the short croup and low tail. We find, too, their type in the feral breed of the *Ukraine*, a stuffed specimen of which now at Dresden measures the almost incredible length of 24 feet along its mane. "We find, too, in comparing them with the wild breeds of other lands, with hot sun and warm sandy plains, with the wild breeds of America, with the domesticated breeds of Asia and Africa, that in reproducing these forms, though left entirely to 'natural selection,' they but obey a law general to all." The facts recorded in the above passages are extremely interesting, but whilst they prove the tendency to vary which all organised beings exhibit, they are not opposed to Mr. Darwin's doctrines, but rather corroborative of them ; they merely show that the horse removed from the conditions which led to its domestic characters lost these latter; and when placed under those conditions which *may* have originally developed its feral characters, it assumed these also.—Vide *Transactions of the Nova Scotian Institute of Natural Sciences*, Vol. II., part 1.

Skulls of Man and Athropoid Ape.—At a meeting of the Zoological Society, held on Tuesday, Nov. 7th, Professor Huxley read a very important paper upon the resemblance which exists between the crania of the children of certain races of man, and those of the higher apes. There are certain osteological features by which both the higher and lower apes resemble man, but there are also certain characters by which the lower forms more closely approach the human type than the higher ones. It is necessary, therefore, in estimating the value of the anatomical indication of relationship, to exclude all those characters of approach to human kind, which are exhibited by creatures whose general characters point clearly to their degraded position in the animal scale. On doing this it will be found that the more important points which demonstrate the relation of the higher apes to man, are the altitude of the cranium, the position of the nasal bones, and the character of the maxillæ. Professor Huxley's examination of the skull of a child from one of the islands of the South Pacific Archipelago has led him to believe that the approximation of the human to the quadrumanous is more strongly marked than has heretofore been supposed. Apparently there is an objection to this conclusion upon the ground that the skull examined having been that of a child, ten years old, the ethnological characters could not have been developed ; but this difficulty Mr. Huxley meets by asserting that in the cranium in question the race characters were so decidedly marked that it would have been quite impossible to have mistaken the specimen for a Caucasian cranium.

The Development of the Bones of the Whale-bone Wales has been shown by Mr. Flower, the distinguished curator of the College of Surgeons' Museum, to afford a clue to the identification of species. In the course of some recent observations made by him upon the anatomy of these animals he found that, owing to the circumstance that at a fixed period the epiphyses of the bones become confluent with the other portions, it would not be possible to meet with adult specimens of certain species, measuring various lengths.

How do Flies walk upon Smooth Vertical Surfaces?—In regard to this question, which has from time to time been answered in all manner of ways, Mr. Blackwall announced his views to a meeting of the Linnean Society, held during the present session. From several experiments and observations carried out by this gentleman during the past summer, he arrives at the conclusion that these insects are not enabled to maintain their position by means of suckers which exhaust the air between the foot and the surface (pane of glass, &c.) to which it is applied. To prove the truth of this view, he employed the air-pump, and abstracted the air from a chamber in which some flies were confined, when he found that they maintained their positions as easily as before. He appears inclined to think that their power of adhering to vertical smooth surfaces is due to a gelatinous fluid which is secreted by the foot-pad.

Relation between the Lemurs and Higher Quadrumana.—This subject, which is at the same time one of the most interesting and difficult problems to be solved by the philosophic naturalist, has lately received the consideration of Mr. St. George Mivart, F.Z.S., &c., Professor of Comparative Anatomy in St. Mary's Hospital Medical School. Mr. Mivart's attention having been concentrated for some years upon the matter in question, his conclusions are necessarily *à priori* of value, but they are so in an especial degree, from the circumstance that in his study of the Lemuridæ he has not confined himself to mere questions relating to size and colour (features, we regret to think, solely considered in too many instances), but has made a searching inquiry into the osteological characters (particularly those relating to the skull and hand) of these animals. From these investigations he was induced to adopt a classification of Lemuridæ very different from that hitherto employed. Omitting Mr. Mivart's scheme of taxological arrangement, which our space does not permit us to introduce, we pass to his remarks upon the relation of Lemurs to the other quadrumana. He proposes to divide the whole of the order *Primates* (including the genus *homo*) into two great groups, the first of which he terms *Anthropoidea*, or man-like; and the second *Lemuroidea*, or Lemur-like. The following, though by no means the only distinguishing characters of these two sections, are, we believe, pointed out now for the first time:—In Anthropoidea, *the internal carotid artery always passes through the petrous bone; the foramen rotundum and sphenoidal fissure are distinct;* and the posterior *corner of the hyoid bone is invariably longer than the anterior one.* In *Lemuroidea*, the anatomy of the structures referred to is of an opposite nature.—Mr. Mivart's paper was read before the *Zoological Society* on Tuesday, Nov. 22nd.

The Principles involved in the Classification of Animals.—In No. 4 of the first volume of the new series of the *Canadian Naturalist and Geologist*, we find an article on this subject from the pen of Dr. Dawson, a gentleman of considerable reputation as a geologist. We call attention to the paper because of its absolute worthlessness, and in order to caution the student (for whom apparently the contribution was intended) against accepting, without question, the Doctor's views. Dr. Dawson seems disposed to think that development is not the basis upon which classification is to be founded—at least, so far as concerns the divisions of the animal world into types. Some of the writer's statements are amusingly erroneous, and show very fully the truth of the old adage, "the shoemaker should not go beyond his last." The scientific world respects Dr. Dawson's labours in the field of geology, but what can it think of a naturalist who states that the divisions Cœlenterata, Annuloida, &c., are examples of a retrograde step in zoology?—or of a physiologist who defines an animal as distinguished from a mineral to be "a being possessing an organisation based on cell-structures and vital force?"

How can Dr. Dawson imagine for a moment that he is rendering the student's path more easy by talking of cell-structures, organisation, and vital force? When the Doctor tells his readers that animals differ from plants in being reproduced by ova, and not by seeds, he lays himself open to the charge of ignorance of the commonest principles of physiology. We trust that when this gentleman again appears in the capacity of a teacher of philosophical zoology, he will have enlightened his mind by a careful study of the researches of those who, without excessive ambition, have been conscientious enough to ascertain the truth of statements before they have committed themselves to generalization.

Peculiar Structures in the Seminal Fluid of Ianthina.—Herr Fritz Müller, in a paper which appeared in *Wiegmann's Archer*, and has been translated by Mr. Dallas, describes some very peculiar structures which have been observed by him in the seminal fluid of Ianthina. In this secretion numerous vermiform bodies may be seen (even with the naked eye) swimming briskly about. Their length is about half a millimetre. With the aid of the lens, two sharply indicated divisions may be observed, which form a sort of head and tail. The head occupies one-fourth of the total length; it is sometimes of a pretty regular conical form; sometimes furnished at its posterior thicker portion with irregular processes; and sometimes projects anteriorly in a double, instead of a single point. It contains numerous granules of various sizes, with dark outlines, which render it rather opaque, and no distinct membrane could be perceived surrounding it. The tail, about three times as long as the head, is anteriorly much narrower than the hinder margin of the head, but becomes gradually enlarged posteriorly, and terminates in a rounded end; it is almost completely opaque, and is densely clothed with delicate hairs of about $\frac{1}{300}$ of a millimetre in length. These hairs are seen to move rapidly, but do not strike in the same direction, as in the case of the cilia; on the contrary, they wave and mingle together irregularly, so that they cannot be regarded as the cause of the rapid movements by which the structures pass through the water in large curves. At a distance of nearly twice the length of the head from its apex, it is preceded by a conical point with delicate but clearly marked outlines, from which a perfectly transparent membrane waves down to about the middle of the head, like a fluttering veil. Sometimes an extremely delicate longitudinal striation is observed in this membrane. Posteriorly its outlines are so evanescent that it can seldom be traced to its hinder margin. In the vicinity of the conical point, several little lobes, resembling narrow cilia, separate from the membrane. While the structure is swimming these little lobes oscillate rapidly and powerfully, and the whole membrane is in lively oscillating movement. Herr Müller first regarded these bodies as parasites, until having invariably found them in the semen, he was led to regard them as an essential constituent of this secretion. Besides, on several occasions, he succeeded in breaking up several tails into groups of unmistakable seminal filaments. He concludes, therefore, that they are "part and parcel" of the semen, and asks, are they the formative organs of the seminal filaments, from which these, subsequently, when mature, separate? or are they spermatophora around which the mature seminal filaments have collected.

Crustacea of the Glacial Epoch in the Scandinavian Lakes.—M. Sars has found certain species of marine Entomostraca in the fresh-water lakes of Norway. *Harpacticus chelifer* was found in a lake in the neighbourhood of Christiansund. In the Mjœsen lake he discovered two species of *Cythere*, *Mysis relicta*, and *Gammarus cancelloides*. In ponds in the environs of Christiania the Amphipod, *Pontoporeia affinis*, was discovered. These species all inhabit the deepest parts of the water, and live quite separate from the true fresh-water forms of crustacea. The discoverer considers the presence of these crustacea in the Scandinavian lakes to furnish evidence that, at the glacial epoch, the basin of the Baltic was in communication with either the eastern or western Arctic Ocean.—Vide *Bibliothèque Universelle*, Sept. 20, 1864; and *Annals of Natural History*, December.

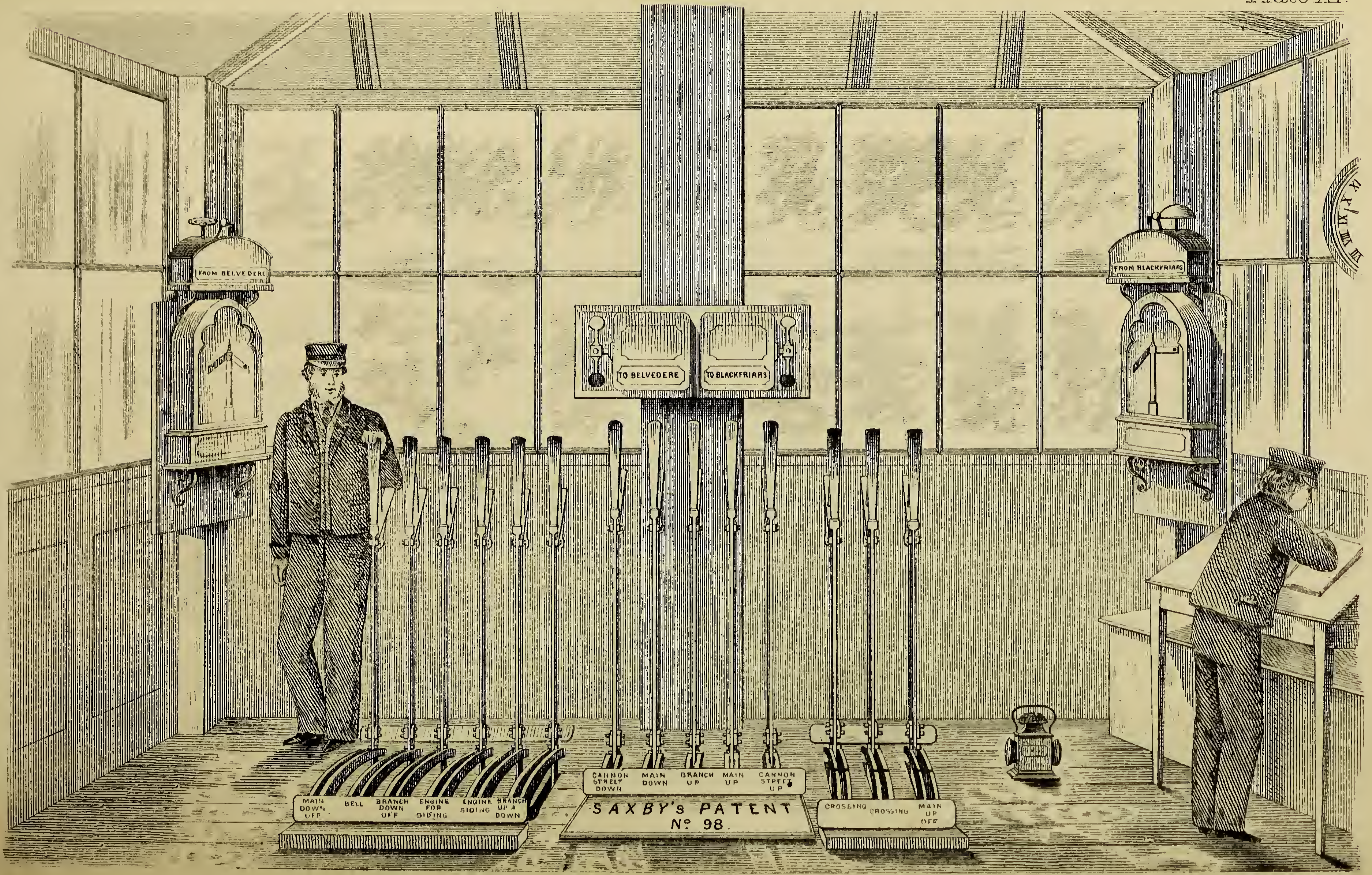
The Development of Raia Batis.—Some very valuable observations upon the development of the above-named skate have been made by Dr. J. Wyman, of Harvard University, U.S. He finds that (1.) the yelk case is formed in the glandular portion of the oviduct, and is begun previously to the detachment from the ovary of the yelk, which is to occupy it. (2.) The embryo, before assuming its adult form, is first eel-shaped, and then shark-shaped. (3.) The embryo is for a short time connected with the yelk by means of a slender umbilical-cord; the cord afterwards shortens, and the young skate remains in contact with the yelk until the end of incubation. (4.) There are seven branchial fissures at first: the foremost of them is converted into the spiracle, which is the homologue of the Eustachian tube, and the outer ear canal; the seventh is wholly closed up, and no trace remains; the others remain permanently open. (5.) There are no temporary branchial fringes or filaments on the first and seventh arches; on the others the fringes are developed from the outer and convex portion of the arch, and are not at first prolongations of the internal gills. (6.) The nostrils, as in all vertebrates, consist at first of pits or indentations in the integument; secondly, a lobe is developed on the minor branch of each; and finally the two lobes become connected, and thus form the homologue of the fronto-nasal protuberance. The transitional changes of these correspond with the adult conditions of them in other species of Selachians. (7.) The nasal grooves correspond to the nasal passages of air-breathing animals, and the cartilages on either side of them to the maxillary and inter-maxillary bones. (8.) The foremost part of the head is formed by the extension of the facial disk forwards. While this extension is going on, the cerebral lobes change their position, and instead of being beneath the optic lobes, come in front of their bodies. (9.) Two anal fins, one quite large and the other very small, are developed; but these are afterwards wholly absorbed. (10.) The dorsal fins change their position from the middle to the end of the tail. At the time of hatching, however, there is still a slender terminal portion of the tail, which is afterwards either absorbed, or covered up by the enlarged dorsals as they extend backward.—Vide *Memoirs of the American Academy*, vol. IX.

How the Nerves end in the Muscles of Insects.—It would appear from Dr. Beale's late inquiries that the nerve filaments never penetrate the substance of the muscle, but are distributed as exceedingly delicate branches to that thin membraneous (?) portion of muscle to which the term "sarcolemma" has been given. "Instead," says Dr. Beale, "of a nerve fibre penetrating the sarcolemma at one point only of the muscle, and becoming connected with nuclei beneath this membrane, a bundle of any fine nerve-fibres, having reached the sarcolemma, ramifies freely over its surface, and is *not* connected with the nuclei beneath, which are probably only concerned in the formation of the contractile tissue."—Vide *The Quarterly Journal of Microscopical Science*, October, 1864.

The Circulation in the Vorticellidæ.—The appearance of the "contractile vesicle" in this family is thus described by Mr. William Handsell Griffiths. Viewing this organ under the miscroscope, he observed, first: "On certain movements of the reflector, the vesicle entirely disappeared; but in subsequent alterations of the position of the reflector, I observed its re-appearance. I am inclined to think that any subsequent contraction-like appearance of the vesicle was due to the fact of its having been removed from the line of focus by the movements of the living animal; to the same cause I also attribute an expansion-like appearance of the vesicle. Hence the characteristic (!) term *contractile* vesicle is inappropriate, unreasonable, and unfounded; the plain word vesicle being truthful. Secondly: I have never witnessed the processes proceeding from the vesicle, stated by Lachmann to have been observed by him. I believe that what he thought to be processes or branches of the vesicle, were merely occasional interpositions of the cilia of the disk between the object and the miscroscope; I believe that the delusion sometimes assumes an almost convincing aspect, not of two distinct processes as Lachmann has observed, but of branches to and from the vesicle, indefinite in their position and number." . . . . "I acknowledge that there is a vesicle of unknown use in the vorticellidæ; I deny the existence of a contractile vesicle acting as a heart. I acknowledge the presence of cilia; I deny that of vesicular branches or vessels. Hence I infer that the statement that there is a circulating apparatus is without foundation, and may only be regarded as a picture painted by a vivid imagination, or an hypothesis promulgated for a selfish purpose." Certainly the concluding remarks are strong, and we confess we hardly think Mr. Griffiths is justified in making so very decided an assertion in regard to the views of others. As concerns his observations, of course, time will alone decide *their* acccuracy.—Vide *Microscopical Journal*, October.

BRITISH MUSEUM

Plate XI.



W. West lith.

Signal Box at Waterloo on the Charing Cross Line

TRAIN-SIGNALLING IN THEORY AND PRACTICE.

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THE object of this communication is to give the reader a hasty peep behind the scenes—to introduce him to certain silent operations that are, hour by hour and minute by minute, being carried on in his interest, but which, for the most part, are known to him only in their results. But how these results are brought about with accuracy so unerring is but little understood by him; and there is no marvel in this. The reader to whom I refer is, of course, a railway traveller; every one travels, more or less, behind the steam horse on the iron road. In early days, when trains were few and far between and their pace was slow, their movements could be regulated with tolerable facility, and without the application of any very special processes. At the present time—so intricate has become the network of railways, so complicated the roads, the stations, and the junctions, and the trains themselves so formidable in number and so mixed in character, that nothing short of special appliances, simple in the extreme themselves, complex apparently in the aggregate, are found adequate to secure the safe and convenient conduct of the gigantic railway traffic of the present age. It is true that the trains of to-day —express, tidal, and such like, move along with what our grandsires would, indeed, have regarded as fabulous rapidity—forty, fifty, sixty miles an hour; but we have that which moves far more rapidly than these—by comparison slow-coaches—I mean, of course, electricity. Wheatstone was the first to measure its velocity, and found it to be 288,000 miles in a second; this is its most rapid rate of motion. When the Atlantic cable lay at Keyham Yard, Devonport, in process of being coiled into the holds of the *Niagara* and the *Agamemnon,* I repeatedly measured the rate at which electric signals travelled, and found it to be about 1,000 miles per second; which is one of the slowest, if not the slowest, rate of travelling on record; and slow, though this by comparison appears to be, it is a thousandfold faster than the fastest of express trains; so that, if we send electrical impulses on ahead, and give them fitting work to do when they reach their destination, we can prepare the way in any form we choose for the coming train. It is well, also, to mention here that the electricity employed for this purpose and the wire road along which it is destined to travel are such that, although it does not attain to Wheatstone's velocity, it very far exceeds the velocity found in the Atlantic cable. It would be foreign to the purpose of this article to explain the conditions under which these differences of velocity arise. It would also be out of place—indeed, space will not allow—that we should enter into any detailed description of the instruments or magazines, so to speak, whence the supply of electricity is derived for the purpose in question. Voltaic electricity is used: we have it as the current form of force. The philosophy and construction of many varieties of what is called the Voltaic battery will be found in every elementary treatise. The particular form employed by myself, and which may be taken as a type of this class of apparatus, is the following:—A narrow slip of copper is fastened to a plate of zinc, and the zinc is cleaned and its surface well saturated with mercury; a plate similar in size is cut from the corrosion or refuse of gas retorts, to which also a slip of copper is attached; the surface of this, which we call graphite plate, is covered with a coat of fine powder of platinum by an electro-chemical process easily carried out, and which is called platinizing. This pair of plates are placed (not touching) in a small earthen jar, filled or partly filled with vitriol and water—sulphuric acid and water—the copper slips being clear of the liquid. In practice the plates are six inches by two inches, and the jar holds one pint. This simple apparatus thus arranged may be said to "stand at ease"—it is ready day and night at our bidding to furnish electricity for at least six months without further trouble; then, for at least a further six months, by replenishing it with acid water, to replace that consumed in action or lost by evaporation; and then for a third and fourth half-year by washing everything and starting it afresh in the first instance, and then again replenishing it for the liquid lost. By this time the zinc may be found to be worn away, and must be replaced; the graphite is practically imperishable. This simple apparatus may be considered as primed and loaded with electricity, and ready to go off at the word of command. The liquid and the plates, with their copper slips, are all conductors of electricity; it can travel by them; the dry jar is not. The respective plates thus mounted are in a state of electric tension; the copper slip on the graphite plate is ready to *give off* electricity; the copper slip on the zinc plate—I use popular language—is ready to *receive* electricity. One mode of allowing these tendencies to operate—of causing the plates to discharge the electricity—is to touch one slip with the other, or to solder a wire to each slip, and to twist the two ends of the wire together. Electricity will pass, and continue to pass, from one plate to the other along the wires, as long as the wires are in contact,—the copper plate giving off and the zinc plate receiving electricity by the intervention of the conducting wire; and at the same time, within the mass of acid water, the zinc plate is giving off and the copper plate receiving electricity by the intervention of the conducting liquid. This condition of things, which is called the *Voltaic circuit,* is shown in fig. 1, where Z and G are the zinc and the graphite plates, and the arrows the direction of the current; and this circulation of electricity will go on, but with decreasing energy, until the active property of the liquid is exhausted. The zinc will then be found to be more or less corroded, and the contents of the jar will be solution of sulphate of zinc, instead of dilute sulphuric acid, as in the outset. The graphite will be unchanged; but during the operation small bubbles, which are hydrogen gas, will have appeared abundantly at its surface, and have risen into the air. No electricity is produced or *made* by this process: it is merely disturbed; none of the materials employed are *lost;* they merely enter into new combinations. The water employed is a compound of oxygen and hydrogen gas: the latter, as we have said, rises and escapes into the air; the former combines with zinc, and produces oxide of zinc, which combines with the acid and forms the sulphate of zinc that remains in solution; and the electricity during these operations moves in a definite direction, in order again to attain to a state of equilibrium. The mercury also is unchanged; it discharges the important office of protecting the zinc from being attacked by the acid (which would otherwise be the case), when the apparatus is not in use for developing electricity. But an absolute *circuit* is not indispensable to a current of electricity; it is not essential that the discharge of the zinc plate should take place by the wire into the companion copper plate: in fact, it does not follow that one end

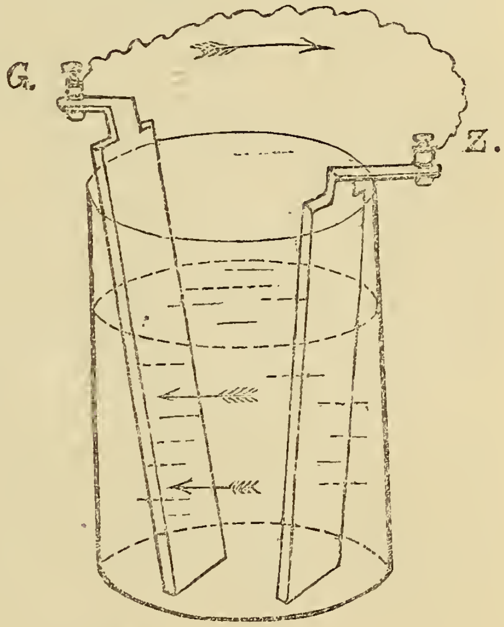

Fig. 1.

of a Voltaic battery should discharge itself into the other end of the same battery—the discharge of either end, or both ends, may be made into the earth; and this is the course pursued in practice—I mean in telegraph practice—for passing signals from place to place. A wire is led from one end of the battery, and, when in the act of transmitting a signal, is connected with gas or water pipes, or with any metals that are in good electrical communication with the earth immediately on the spot; and a wire is led from the other end along telegraph poles, through tunnels, or under the sea, for miles and miles, as the case may require, and is there in like manner placed in good communication with the earth; and so long as the communication is maintained perfect, and until the battery is exhausted, as above described, a current of electricity will pass along the wire. One battery cell is, however, not sufficient to produce a sensible result at a distant place; for this purpose a series of cells more or less numerous are arranged, the zinc of one being connected metallically with the graphite of the next. For the Train-Signalling Instruments to be described in the sequel, ten or a dozen cells are used for short distances; the number being increased as the distance is greater.

A telegraph wire, while transmitting a voltaic current, is active along its entire length; and there are many ways of turning this activity to account. We are concerned with one property alone: it is the power possessed by such a current of converting soft iron into a magnet. The power of a single current is small; but the same current in its course may be made to act many times on the iron until the desired effect is produced. For this purpose a quantity of cotton-covered copper wire is wound round the iron, and the current is made to pass from end to end of the coil of wire, its effect on the iron being multiplied by the number of convolutions. Such an instrument is termed an electro-magnet, and is employed in its simplest form for interpreting voltaic currents into audible or visible language. A couple of brass bobbins 3 in. by 4 in., as in fig. 2, are prepared; and upon each

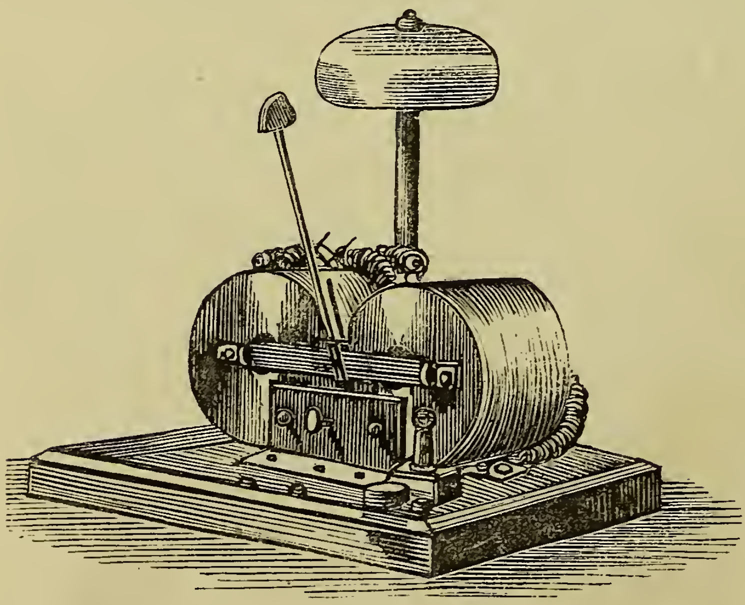

Fig. 2.

of them is wound about five pounds of large size cotton-covered copper wire; a rod of iron is bent into a sort of U-shape, and its arms are thrust through the bobbin from behind, their ends being flush at the front. Facing the ends of this iron core is carefully pivoted the plate, or keeper, of iron, visible in the figure, carrying a slender rod, to which is affixed a hammer; a large bell, 3 to 6 inches, or more if needed, in diameter, mounted on a stem, completes the instrument. This is the "Train-Signal Bell" that has been on the South-Eastern Railway since December, 1851; and of which, at the present time, about 400 are in daily and constant use for the sole purpose of signalling trains on the 308 miles of which that railway consists. This instrument, and the manner in which it is employed, are more than typical of train-signalling generally, and are the best illustrations that can be selected of the system. The instrument itself, more or less modified in construction—never larger or more powerful, almost invariably on a smaller scale—and the language educed from it, are at the foundation of all the best-devised systems,—the systems that, one by one, during the last few years have cropped up on the best-conducted railways. In the majority of cases further appliances are introduced, the nature of which will be given in the sequel; but the bell and the bell-signals are the substance and foundation of the whole, and the systems would be impracticable—would fall through, if these signals were withdrawn.

The action of the bell is very simple, and may be anticipated from what has been already said. When a current of electricity traverses the coils, the U-shaped iron core becomes a magnet; and of course has the well-known property of attracting iron, in virtue of which the iron plate, or *keeper*, as it is called, is drawn forward, carrying with it the stem and hammer, and causing the latter to strike loudly upon the bell. When the electricity is cut off, the magnetism ceases, and the keeper recedes, assisted by a spring, visible in the figure. If a second and a third current of electricity are successively sent, a second and a third blow will be given on the bell, and this is the bell-language: one blow has a meaning of its own; two blows have a different meaning; three, still a different; and so on. The requisite number of currents of electricity are sent by a very simple action: a spring or key is pressed down, like the key of a piano-forte, one or more times, according to the number of signals required to be made. A spring of this kind is shown on the right side of the bell (fig. 2). The sound of the bell can be heard at a great distance.

In order to illustrate the laws of train-signalling, it will be better to take the simple case of a railway like the Ramsgate-Margate, for instance, having two pairs of rails, an up line and a down line, with a signal station at each end, but no intermediate station. The fundamental law is,—"Two trains or engines are not to be allowed to run on the *same* line, between two signal stations at the *same time*." In order to carry out this important regulation, upon which the security of those who travel so largely depends, "Every train or engine must be signalled *out* to the next station, before it *leaves* or *passes* a station." So that when the business of the day, for instance, commences, station B knows that train No. 1 is asking permission to come to him from station A; and, to prevent all misunderstanding, "The train or engine must not be started, or allowed to pass, until the next station has *taken* the *out* signal." It is not enough for the first station to *give* the signal, the other station must *take* it; for "no signal *given* by one station is complete until *taken* by the other station *repeating* it;" by which process a clear understanding is established between the two signallers, that the precise signal *sent* by one is *received* by the others. The next rule applicable is that "Every train or engine that *arrives* at or *passes* a station is to be immediately signalled back *in* to the last station;" and it follows, from what has been already stated, that "No second train or engine is to be allowed to follow until the *in* or *arrival* signal of the *previous* train has been taken,"—that is to say, has been repeated back blow for blow.

And in order that there may be no mistake as to whether or not the whole of the train is safely in, it is not to be signalled as *in*, until "after it has been clearly ascertained by *actually seeing the tail-lamps*, or communication with the guards, that no portion of the train from any cause has been left behind." These are the leading features of train-signalling, and they are quoted verbatim from well-digested regulations. It will be noticed that there is a double check against accident from collision, through a train following,—the *in* signal of the first train must be given and received; the *out* signal of the second train must be answered,—must be repeated back. So that if from any oversight an attempt were made by station A to get permission to send a second train before the first was in, the attempt would be defeated by station B declining to answer. In addition to all this, and all of which is done in far less time than it takes to describe, the signals, and the time of making them, are entered in ruled columns by both stations. Signal-boxes are furnished with good clocks, which are checked by a daily time-signal from the Royal Observatory, Greenwich. For the ordinary purposes of train-signalling, the greatest number of blows on the bell is THREE; and this number may be made in about two seconds, or less. The code, with its interpretation, is :—

One blow for every Up train or engine	OUT.
Two blows for every Down train or engine	OUT
Three blows for every train or engine	IN.

In each signal-box a battery, with the proper number of cells, is mounted, a bell is set up, and a ringing-key, mostly detached from the bell for convenience of access, is firmly fixed; and *one* single telegraph wire is extended from station to station. The signalmen are not expected—they are not required—to look after their apparatus; it is so simple that it almost takes care of itself; it cannot—indeed, it is essential that it should not—very easily get out of order. All they have to do is to make and enter the signals.

Many Level crossings—roads used by the public—exist on the South-Eastern Railway. At all these there is a gate-keeper to open the gates or to close them against road-traffic, according as trains are at hand, or not. There is a crossing of this kind between Ramsgate and Margate. In the gate-house, as in all others, is a signal-bell. The gate-keeper is not provided with a battery, and has no power to send signals; but the bell is so placed in the circuit of the telegraph wire that every signal, passing between the stations, rings this intermediate bell, and warns the gate-man in language that cannot fail to be heard and understood, of the trains, up and down, that may be approaching. These are called "hearing-bells;" and are used for a variety of purposes. At Margate, for instance, and many other places, the signalling is done in a box at some distance from the station; but in order that the station authorities may know what is going on, and when trains are at hand, the current of electricity is not allowed to enter the earth until it has passed through a "hearing-bell" on the Margate platform.

Next in simplicity to a signal-box at either end of a line with two pair of rails, is that at an intermediate station on a similar line. In this case the signal-box is provided with a pair of bells of different tones, or a bell and a gong or steel spiral. They are placed on either side of the box, each being at the side nearest to the station with which it is in communication. This arrangement may be seen in Plate XI., which represents the interior of one of Saxby and Farmer's signal-boxes, and of which more presently. The rules already given are equally in force here, and are carried out precisely in the manner above described. Trains come and go in either direction, *stopping* to take up and put down passengers, or *running through*, as the case may require; the signalman by the sound of his bell, by the direction from which the sound comes, and by the number of blows heard, knowing, on the instant, whether it is a train coming or one gone and safe in, and which train. It will be seen that the capabilities of the instruments used for signalling trains are very limited, and they can do only one particular kind of work,—the work for which they are constructed, and none other; and this they must do not only with unerring accuracy, but very rapidly indeed: they have but little to say, few speeches to make; but what they say must be to the point, clear and explicit, and very quickly said. There is not time to spell out words and sentences, as with the ordinary speaking instruments, neither is there time for much manipulation to make signals, nor for much looking to read them; the eye for the most part is otherwise occupied: a touch, and the signal must go; a sound, and the ear must be arrested and the signal received. Let the reader cross the foot-bridge at Hungerford at any time, but especially at the busiest hours of days when traffic is heavy, and he will see how quickly the trains follow each other in safety, when protected as they are by a proper system of signals. As soon as one train has passed the signal-box on the Surrey side, a second may follow in safety from the Charing Cross Station. As many as four trains have here followed each other in five minutes, which would be impracticable without the aid of electricity. On the day of the Foresters' fête (August 19, 1862) no less than 535 trains were signalled at one intermediate station in the London Bridge yard on one pair of bells from early morning till late at night, all the signals also being booked.

There is a rule essential to intermediate stations, but of course not required at a terminus, that the "*out* signals of passing trains are to be made as they *approach*, in order to let them pass without check *if the line is clear*," because unless the *out* signal, as we have already stated, be replied to, that is, unless the out signal, which means "May I send the train?" be repeated back, which means—"You may send the train,"—it would have to be checked; for, under such circumstances, from whatever cause arising, "the train must be brought to a stand, and the driver cautioned to keep a good look-out, because he is running by sight and fixed signals, and not by telegraph signals."

I have heretofore confined myself to the code which is established for the simplest case of train-signalling, and which is applicable and is applied and in force on about five-sixths of the railway in question; and, before passing on, to give one or two illustrations of special codes provided for mixed traffic, which requires distinctive signals, I may here give certain constant signals that are universal in their application, and may always have the same meaning. When a bell is struck *five* times, it indicates that the line is *blocked*, and that nothing must be allowed to come on until a signal has been given that the line is *clear* again, which latter signal consists of *three* blows given and taken *twice*. The telegraph inspectors give sign of their presence and test the condition of the apparatus by exchanging *six* blows; and an erroneous signal is cancelled by *seven* blows.

The simplest case of deviation from a "general code" of signals is when the trains of two companies travel on the same lines, as the South-Eastern and the Brighton trains between London and Red-hill. In this case one blow indicates a South-Eastern train, whether up or down; and two blows a Brighton train; all other signals remaining unchanged:—or to take a case somewhat more complex and which is the oldest of the codes, dating as far back as October 29, 1851, and provided originally for up trains on the half-mile of line intervening between Spa Road and the entrance to the joint station at London Bridge—*one* blow for a Croydon train, *two* for a Brighton train, *three* for a South-Eastern train.

Another old-established illustration of the manner in which bell language, limited though it is in extent, can be modified to meet the necessities of the case, is to be found on the viaduct extending from London Bridge station to near New Cross. There are, on the west side, three lines of rails, one of which is used for all *down* trains, which consist of trains for Dover, for Brighton, for Epsom, and for the Crystal Palace; one of the *up* lines is used for Dover and for Brighton trains; the other for Epsom and for Crystal Palace trains. Distinctive signals are required—*one* blow on the bell is used for all trains down; and *two*, *three*, and *four* for the up, distinguished into three classes; and on account of the rapidity with which the trains, particularly the down trains, follow each other on the same line of rails, special regulations are in force as to the mode of answering and the mode of reporting a train in. Also when the down trains are approaching the junction on the hither side of New Cross, where the Dover and Brighton trains have to be sorted out and turned on to one pair of rails, and the Epsom and Crystal Palace on to another pair, the signals also are separated and sent on ahead on different wires and bells.

Heretofore, the illustrations have been mainly confined to the cases in which two bells constitute the system; but at junction stations, a third bell, and in some cases a fourth, is required. They are all properly placed; and their tones and position and language are very definite; and all that has been said above applies equally to them. In cases where it is required, a counting index is an appendix to a bell, which tells off and indicates the bell that has been sounded, and the number of blows that have been given.

It has been further thought advisable, especially where the trains up and down are very many in number, that the signalman should be reminded by some signal visible to the eye that he has given or taken a certain bell signal; and this visible signal is further turned to account by being used in combination with the audible signal; and thus diminishing the number of sounds necessary for carrying on the traffic. The visible signals at a glance show the actual state of the line, whether a train is coming or not, whether a train is still going on or is safely in; in fact, whether the lines in either direction are free or not of trains.

The Charing Cross Railway, where a system of this kind has been in full operation since the opening, will give a very perfect illustration of the joint service of the eye and ear in interpreting what the hand has given.

Plate XI. shows the manner in which the signal-box at Waterloo is fitted up. This box is intermediate between Belvedere Road and Blackfriars. At the front of the box, in the right and left-hand corners respectively, are placed a bell and an "Electro-Magnetic Telegraph Semaphore." Externally, this instrument presents to the eye a signal-post on a small scale, similar to those in use on the railway in question, with a red arm on the left side and a white arm on the right side, in like position with those on an actual signal-post, and capable of being moved, by an electric current, *up*, indicating danger, or *down*, indicating caution, as required. And the regulations for working them are such that the arms at all times indicate the state of the line. Looking *towards* a semaphore, whether actual or electro-magnetic, the red and left arm has reference to trains receding; the white and right arm to trains approaching; and when an arm is up it indicates that a train is on the line, and when down that a train is not on the line. So that, looking at the position of the arms as they stand in Plate XI., it is evident that no train is going from Waterloo to Belvedere, and no train is coming from Belvedere to Waterloo; both lines on this side of Waterloo are clear. On the other side, there is no train going from Waterloo to Blackfriars; but a train is on its way from Blackfriars to Waterloo. These semaphore instruments are connected up in pairs; the one on the right hand of the signal-box is connected with its companion at Blackfriars, and works in sympathy with it, the arrangement being, that "the red arm at one station and the white arm at the other station work up and down together. When the red arm at one station is up, the white arm at the other is up also; when the one is down, the other is down." If an observer were at Blackfriars, he would find the companion semaphore in question on the *left* side of the box there, and labelled Waterloo, and would see the left, the red arm, *up*, in sympathy with the white, the right arm of the semaphore in the engraving; and the white arm *down* in sympathy with the red or left arm in the engraving; and the signal-man at Blackfriars would make no attempt to signal on another up-train until the red arm at his station had been put down by Waterloo.

The principle upon which the Electro-Magnetic Semaphores are here connected up and arranged, is that "each station can put the white arm only at his own station, and the red arm only at the other station, up or down." No signal-man, in this arrangement, which may be varied to meet other cases, has power to alter the position of his own red arm; it is put up behind a train by the next station, and put down when the train is in at that station.

It will be more convenient here, in explanation of the manner of working these instruments, to describe the whole process of signalling a train by bell and semaphore; and we can then pass on to the description of the electrical arrangements that are employed for bringing about the result.

"The ordinary position of the arms of the Electro-Magnetic Telegraph Semaphores will be down," that is to say, when the line is all clear of trains, and business begins, say in early morning, all the arms will be down, indicating that no train is moving. When the first train is ready to start, say from Charing Cross, the signal-man will give the proper bell-signal to Belvedere on the bell, two, three, or four blows, according as the train is for Greenwich, for the North-Kent, or Mid-Kent, or for the Main line; and the Belvedere man will acknowledge this by one blow on the bell in reply, and without raising the Charing Cross red or left arm: this is the signal that the train may go on; and when the train has passed, so that the Charing Cross man can see the tail lights, he gives the out signal a second time, which the Belvedere man acknowledges, at the same time raising the red arm at Charing Cross behind the train, and so protecting it until it has passed him at Belvedere, when he signals to that effect to Charing Cross, at the same time putting down the red arm there as an indication that the line is again clear. While these operations are going on for down-trains, others precisely similar, but in the reverse direction, are going on for up-trains. The separate functions, as well as the combined office of the bell and semaphore, will thus be readily apprehended. The bell, the basis, as we have said, of all the more sound systems, as heretofore speaks to the ear, and asks, not only if *a* train may come, but defines the particular kind of train that is ready to come; and it also tells at the proper time that the train is in. The semaphore arm has two motions, and communicates alternately and puts on record two facts only, and most important facts they are,—either that a train is on the line, or that a train is not on the line; and as either one or other of these things must always be the case, it is a standing record, at any and at all times, of the actual state of the line, and is of very great service to the signal-man, in regulating the enormous traffic with which he has to deal. The combined office of the bell and semaphore is now evident. It is not enough, as we have seen, that the arm of the semaphore indicates the line clear: before a train is allowed to go, ideas must be interchanged by bell-signal; and if the reply is combined with still displaying the all-clear signal, that is the red arm down, the train may proceed; nor is this enough, for it would be a contradiction after the train had passed, and is therefore on a certain length of rail, for the all-clear signal to remain displayed; and hence it is that a second interchange of out bell-signals is made, this time indicating that the train had come on as allowed; and the reply in recognition of this is combined with raising the red arm behind the train, and retaining it there until the train is safely in. It is then lowered without any further interchange of signals; and so on. It takes far longer to describe these operations than to perform them. The bell-semaphore signal is the result of a single act,—one and the same pressure on the key sends a bell signal and raises or depresses the semaphore arm as the case may require,—a single telegraph wire only being required for the combined system, as for the more simple bell system.

This arrangement carried on thus far is all very well for the Charing Cross line proper, which at present consists of only an up and a down line; but at the London Bridge Station, the several kinds of down trains have to be sorted out, and switched to the lines leading to their various destinations; and on the other hand, up trains from different lines have to be collected and switched one after the other, onward on the one line to Charing Cross. The first distinctive change is that the two lines of rails as they enter the London Bridge Station become four, and are protected by two pairs of electro-magnetic semaphores instead of one pair; and have of course bell-codes modified to suit the necessities of the case. And then, when well in the yard of this station, the roads increase in number and in intricacy. Any attempt to describe them and to enter into the details of the telegraph arrangements provided for their protection would be more tedious to the general reader than profitable. The whole is conducted on the principles so fully explained,—the apparatus being increased in number according as the roads are multiplied. The greatest number of Bell-Semaphores in any box in the London yard is six; and they are worked there in a modified form, in order to meet the speciality of the place. In one of these boxes, 650 trains or engines were signalled, and mostly by bell alone, on Whit-Monday, 1864, May 16, between 5.30 A.M. and midnight, all accurately entered in the books, twelve figures being required for the entry of each train or engine,—amounting in all to 7,800 figures,—so much care is taken for the protection of the public, and so much serious work is quietly and successfully carried on for their advantage and security.

In stating the mutual relations between voltaic currents and electro-magnets, in order to explain the action of the signal-bell, it was enough to say that an electro-magnet has the power of attracting the iron keeper, whenever a voltaic current traverses the wire that surrounds the iron core. This single property will not suffice to the twofold action of the Electro-Magnetic Telegraph Semaphore,—the putting a signal-arm up, and then again putting it down. When a current circulates round a bar of iron in one known direction, the near end of the iron becomes a north pole; when the direction is reversed, it becomes a south pole. The north pole has the property of attracting the south end of a permanent steel magnet, and of repelling the north end;—the south pole attracts the north and repels the south. Advantage is taken of this property in order to produce the two required motions. A couple of bar-magnets are so mounted in a movable system in relation to the two poles of an electro-magnet, that the action of the latter on the four poles of the magnets is combined to produce motion in one direction with one current of electricity, and in the reverse direction with the reverse current; and the motion is transferred in a very simple manner to the arms of the semaphores.

And the arrangements are such that the arms are firmly *locked* in the position into which they have been placed by the electric current, so that no amount of vibration from passing trains, and no external violence, accidental or otherwise, can displace them; nothing, in fact, can alter their position, save an electric current sent in the reverse direction. The locking-plate is an armature, acting independently of the system of magnets, which releases them by the same current that is used for shifting them.

It remains to mention that for the simple key or contact-maker, previously referred to, and used for sending only one kind,—either kind of current for mere bell-signals, is substituted the "Semaphore key," shown on the post in the centre of the Waterloo box, Plate XI., which is nothing more than a mechanical arrangement of springs and studs, so connected with the battery, the semaphores, and wires, as to distribute the required currents in the required directions at the will of the operator. It is placed within easy reach of the signal-man. In this instance there are two keys, that on the right hand for Blackfriars signals, that on the left for Belvedere signals. Each key, as here arranged, has an upper and a lower knob, the respective duties of which are simple enough; the current sent by pressing the upper knob puts up the semaphore arm, that sent by the lower knob lowers it. By this arrangement the man has perfect control over the bell and red arm of the semaphore at the next station, and its companion white arm at his own station, and can send, on the instant, signals to put an arm up or down, as he requires it; or he can make any amount of bell-signals, in reply or otherwise, without moving, if he does not wish to move the arms above mentioned. Over the red arm at his own station, and its companion white arm at the other station, as we have said, he has no power.

I have endeavoured thus far to explain the science of train-signalling, in so far as the signal-men themselves are concerned. I have described the apparatus with which they interchange ideas, the manner in which they use it, and the rules by which they are guided. But they are only middlemen, as it were; the knowledge they thus acquire is not for themselves, but for the engine-drivers, to whom they have to communicate it, as they drive up one after the other with the successive trains. This is done by the aid of the long levers that are shown in the centre of Plate XI.

When a train is approaching, its name or destination having preceded it by bell-signals, the first step is to prepare the road for it, if not already prepared; and this is done by pulling forward a lever, attached to the proper points or switches, which is known from the labels that are seen in front of them. When this lever is out of the way, in other words, when the proper road is prepared, and not till then, two other levers are unlocked, and can be used; one of them puts the arm down of a distant signal, in the direction of the coming train; and the other puts the arm down of the post over the signal-box itself. If, from oversight, the signal-man were to have attempted to put down the arm belonging to a road, which was not prepared for a train, he would have failed; for he would have found it locked. When the train has passed, the levers, and with them the visual-signal, are restored to their original position, and locked there. When Saxby's system is in use, as it is on the Charing Cross extension, the security obtained by this arrangement is obvious. The signal-man is unable to set the points for one road, and signal the engine-driver on to another road, because he is unable to get any visual-signal down, save the one having reference to the road he has prepared. The various labels in front of the levers in Plate XI. have reference not only to the direct line between Charing Cross and London Bridge, but also to the junction with the South-Western Railway, as well as to the Cannon-Street Road, not yet opened.

I have already referred to the box in the London yard having the greatest number of electro-magnetic semaphores; this box has fifteen levers for working points or switches, some of which work simultaneously two pairs of points; it has seventeen levers for arms on the signal-post outside the box, and two others for distant signals. In addition to which it has seven "discs," which work in unison mechanically with signals at the neighbouring signal-box, and show how they stand. This is a very perfect specimen of a signal-box, and illustrates very thoroughly the working of the telegraph system as between signal-man and signal-man, and the visual system as between signal-man and driver, combined with the locking system of levers and the permanent telegraph semaphore signals as between the signal-man and himself.

At this particular spot roads and cross-over roads form a perfect network; but the multifarious points and signals are so arranged that before any one of the seventeen arms can be lowered on the signal-post, all the points for the particular road to which that signal belongs must be properly set; and this having been done and the signal lowered, it becomes impossible to alter any other points or to lower any other signal-arm, that would tend to allow another train to start and cross the track of the one already allowed to proceed.

At the risk of being a little obscure in the absence of a diagram, I will conclude by giving the routine observed here in admitting, say a Dover train, into and through the London Yard on its way to Charing Cross. Call the first box it approaches AB, and the second CD; AB has already been informed, by bell-signal, that a Dover train is approaching. He then signals it to CD by the bell-semaphore, belonging to the Dover-Charing Cross line. If CD is ready to receive it, he first sets his road right for it to travel upon, then lowers the proper arm on the signal-post; and, in doing this, he shifts mechanically a "disc" in AB box, which indicates what arm he has put down; and, finally, replies to the telegraph-signal of AB upon the bell-semaphore, lowering a white arm in his own box and a red one in AB. Then, and not till then, AB will lower the proper arm on his own signal-post, and allow the train to come on.

The remarks that have hitherto been made have reference to what may be called "train-signalling proper." But this does not represent the full extent of service rendered by electricity to the traffic managers of railways in regulating their trains. All stations and all signal-boxes, when required, are furnished with speaking telegraphs for use in emergencies, and for exceptional cases. The time of the departure, for instance, of every special train, for which no time-table has been issued, is signalled in this way from the departure station to every station on the route; so that every one knows when to expect it, and is able to make provision to keep the line clear. This is all independent of, and in addition to the train-signalling proper from station to station. Express and tidal trains are usually signalled in this way from one first-class station or junction to the next; and they, as well as all other trains that are out of time, are so signalled to all stations concerned. Royal specials are always so signalled, and the chief officer of the telegraph always accompanies them with the necessary staff, and apparatus for establishing telegraph communication instanter from any part of the line, should occasion require. The signal-bells also that have formed so much the subject of this communication can be arranged without any alteration, and without any additional expense, merely by connecting them up differently,—to be rung from any part of the line without the use of any portable apparatus.

In thus illustrating the theory of train-signalling, my endeavour has been entirely to avoid supposititious cases, and to take for examples cases that have a real existence. The illustrations are taken from a railway with which I am of necessity perfectly familiar, and where no expense has been spared to carry out train-signalling to the highest degree of perfection—a railway where the traffic is so large, that nothing short of a very carefully-elaborated system would give the officers confidence to do what they undertake to do. And all that has been said here of one railway is applicable in a greater or less degree to all other railways, in proportion as they have with more or less skill and discretion availed themselves of the services that are to be derived from electricity.

The interior of a large signal-box, such as the one we have correctly designated CD, exhibits a very animated scene, in which there are but two actors, a man and a boy, both as busy as bees, but with no hurry or bustle. The ruling genius of the place is the strong, active, intelligent signal-man, standing at one end of the apartment, the monarch, for the time being, of all he surveys. Immediately before him in one long line, extending from side to side, is a goodly array of levers, thirty-two in number, bright and clean from constant use and careful tending, each one labelled for its respective duty. Before him, to the right and left, are the various Electro-Magnetic Semaphores, each one in full view and adjusted in position to the pair of roads to which it is appropriated, and all furnished with porcelain labels. Direct in front of him is a screen, along which are arranged the various semaphore keys; and on brackets, discreetly distributed, are the bells and gongs, the twin companions each of its own semaphore. Before the screen are the writing-desk and books; and here stands the youngster, the ministering spirit, all on the alert, to take or to send electric signals, and to record them—his time and attention being devoted alternately to his semaphore keys and to his books; being immediately under the eye and control of the signalman. This is no place for visitors; and the scenes enacted here have little chance of meeting the public gaze; indeed, the officers whose duties take them hither occasionally, are only too glad to look on and say as little as may be, and not interrupt the active pair, between whom there is evidently a good understanding in the discharge of duties, upon the accurate performance of which so much depends. Looking on, the man will be seen in command of his rank-and-file;—signals come, are heard and seen both by man and boy; levers are drawn and withdrawn, one, two, three, or more; the arms and lamps on the gigantic masts outside, of which there are three well laden, are displayed as required,—distant signals are moved, points are shifted and roads made ready, telegraph signals are acknowledged; and on looking out—for the box is glazed throughout—trains are seen moving in accordance with the signals made; and on the signal-posts at the boxes right and left, for here they are within easy reach of each other, arms are seen up and down, in sympathy with those on the spot and with the telegraph signals that have been interchanged. There is no cessation to this work, and there is no confusion in it; one head and hand directs the whole, so that there are no conflicting interests and no misunderstandings; all is done in perfect tranquillity; and the great secret is that one thing is done at a time. All this, which is so simple and so full of meaning to the expert, is to the uninitiated intricate and vague; and though he cannot at first even follow the description of the several processes, so rapidly are they begun and ended; yet as the cloud leaves him, and his ideas become clearer, he cannot fail to be gratified and to be filled with admiration at the great results that are brought about by means so simple.

EXTRACT OF MEAT.

BY CHARLES BONER.

EACH day of our existence we are made sensible of the benefits we owe to science. We enjoy them, not absolutely ungratefully, but rather without thinking at the time how they have reached us; for they present themselves to us on such various occasions, that we are accustomed to accept them without stopping to heed the one source whence they all—and whence only—they flow. Science influences the provision of the commonest necessities of our life to such an extent, that the poorest among us would now be unable to dispense with its help but for a single day. Deprive him of some few of the benefits which science has placed at his disposal, and he, poor as he is, will complain of the injustice and the merciless tyranny; and at once declare himself the most ill-used and unfortunate of men. Beggar though he be, he would appeal against the monstrous act as vehemently as he would if unlawfully imprisoned, and thus that palladium of English liberty—the Habeas Corpus Act—were violated in his person. Though not aware of the fact, science has propounded her laws for him in rags as much as for any one else. But he only knows of "the creature comforts" he receives, and does not ask whence they come, or how. This, however, he knows, that he neither can nor will do without them. They are become to him matters of course; and he is no more able to conceive of a time when they were not, than of a world without a sun.

One of the striking attributes of science is its unselfishness. It disinters the ore, separates the metal from the surrounding dross, and lays it, purified and fit for use, by the wayside for the passers to employ as their ingenuity or their necessities dictate. Of the thing thus found one makes a weapon, another a household implement, and a third a crown. Each turns to account as he may or can the knowledge—the fact—that science has thus put before him, to accept it as a free gift if he so chooses, to disregard it, or adapt it to his own purposes, as he feels inclined.

Should years pass and the gift lie unheeded, science is nevertheless amply rewarded. For in its researches it never had in view *the application* of its discovery; that it leaves to others. The sole aim was "to know;" to know exactly, surely, thoroughly. If, however, some wanderer on this world's many thoroughfares observe the thing thus lying on the road-side, and suddenly perceiving how it may be applied carries it away and employs it for the delight and astonishment of the world, and for his own immediate profit, then also is science perfectly satisfied, and rejoices that the result of its labours should prove a blessing to mankind.

But that which, when thus found, proves such a godsend, may long lie unheeded. One passer after the other goes by; they all see it, but to them it is a mere fact,—a bare and barren fact. At last one comes that way who for years has been brooding over some cherished plan, some notion which he is unable to realize. Difficulties which he cannot evade always present themselves; mysteries which he cannot solve puzzle and defeat him. If he could but resolve them! And so he carries about with him this one thought, this undying hope, this plan of half his life, which is always about to quicken and have existence, but which always, just at the boundary-line, fails to receive vitality. It is as though the one thing—the spark, the breath, the vivifying contact—were wanting. It has not yet been found, and so the embryo thought cannot ripen and come forth.

Now this chance wayfarer, with the ever-present thought in his brain, passes on his road the fact cast there by science. He glances at it. A sudden light seems to burst in upon him. With an electric shock the vital spark is communicated to the thought which wanted but this to make it quicken, to give it animation, to cause it to come forth, and have a being, and live. The mysteries which so bewildered him are cleared up; the difficulties which opposed him he now can overcome. At last the discovery is complete. He carries out his plan, the new method is successful, and he and many others have reason to rejoice.

In this manner a result has just now been arrived at which promises to be a boon to man. And as it is interesting to see how the thought originated, then lay in abeyance, and finally, after fourteen years, was rekindled by the chance finding of a fact thrown by science on the wayside, the following account has been written as a record. For it is from this very wayfarer, with the ever-present thought in his brain, that I have the interesting story. And as he one day related to me the first conception of his idea, of his defeats, misgivings, hopes, and final success, so do I here repeat the tale that others may profit by it, and learn never to despair.

George Christian Giebert, a German civil engineer, had been employed by the Brazilian Government in the construction of roads; and while in Brazil had opportunity of learning that the country so praised for its fertility suffered everywhere from a painful scarcity of food. Later, when in the La Plata states, he saw the herds of oxen that were daily slaughtered for their hides and tallow only; and as the sale of these ensured a sufficient profit, little account was taken of the flesh of the animals. It was not wholly lost, however; for large quantities, after being dried, were laid up for future use.

To an observant mind the thought would naturally present itself, "How desirable to transport to countries, less plentifully supplied, the superabundance of food which is to be found here!" England, to supply her growing marts, imports oxen from Holstein, and corn from all quarters of the globe. In Brazil is scarcity, while here the most excellent beef is to be had for the asking. But what was to be done with the meat, and how convey it thither where it was wanted? To salt it requires workmen and casks for packing; but the price of labour is so high as to destroy the advantages which otherwise would arise from the small cost price of the article to be exported.

Then the volume, too, of the food in such a form presented difficulties for inland transport, and added to the cost even of sea-carriage. Year after year experiments were made to compress into a small space a large amount of flesh without a loss of its nutritious qualities. They were persevered in: for Herr Giebert saw how great a benefactor he would be to over-populous Europe could he succeed in bringing thither, at a small cost, the vast quantity of nutritious food which, on the plains of La Plata, was so little regarded. But the attempts of fourteen years led to nothing.

Suddenly a ray of light illumines all, and shows the seeker where what he sought for is to be found. And it happened in this wise. Far away in a little German town lived another man, also a searcher and a solver of difficulties, and he, too, had thought much on the subject of food. He had analyzed the different substances man used for his nourishment, discovered the relative value of each and of the component parts, and had separated the essence from the mere non-essential husk. This man was Liebig. The result of his experiments, made many a year before, he gives to the public in a book called "Chemische Briefe."

This book, as it happens, falls in the way of that other man in South America, who for a decennium and a half has been racking his brain with the solution of a difficulty. He finds in it the thing he wants; the means of extracting from meat its very essence, and of thus giving in a small space a large amount of nourishment.

So off he starts at once to talk with the author of the book, to tell him of his plan, to hear his opinion, and to ask for his advice. The chemist, who, sixteen years before, had obtained his pure essence of meat, is overjoyed at the meeting; for he was well aware of its qualities and of the good that would follow, could it only be brought into general use. Often had he wished that its production were possible, so as to place it within the reach of all, that men might buy it even as they buy bread. But he clearly saw the insurmountable difficulty; for to obtain one pound of essence thirty-two pounds of meat are wanted; and it were no advantage, in a pecuniary point of view, to furnish in one form a thing that could be had for the same price in another. But still he hoped that what he believed would prove so great a blessing might one day be realized. He had made his analysis, and he trusted that another would turn it to good account.

And behold! that man has come! He comes to say that though in Europe, where beef is dear, it were useless to make such essence, he knows a land where meat costs next to nothing, and to that country he will go and make his nutritious extract, and send it hither for general use, and at a price which shall place it within the reach of rich and poor alike.

Then the two men, each furnishing the completing circumstance which alone rendered the cherished plan of the other possible, discuss the matter together. The one gives his scientific knowledge; gives the result of all his examinations, experiments, and trials. The other accepts this as stock-in-trade: he orders boilers, steam-engines, and all necessary apparatus; has a plan for a building laid down, with storehouses and workmen's dwellings; and leaving wife and family in Europe behind him, starts off again with half his fortune for La Plata, there to put in operation and carry out the thought that first germed in his brain fourteen years ago on the plains of South America. And so, God willing, we, in a month or two, shall have in our kitchens and hospitals the juice and essence of the strong oxen now feeding on the Pampas.

But let us examine what this preparation is,—this new "boon for man," which our two men, each unknown to the other, have for years been brooding over, and would not give up the idea of one day realizing. First, how is it obtained?

From a certain quantity of fresh beef every particle of fat, bone, and tendon is carefully removed. It is then chopped up and placed in a vessel, with a small quantity of water, in a water-bath, great care being taken to remove the albuminous coagulation which forms, as well as any fatty matter which may show itself.

After a time a pale brown, thickish fluid, of the consistency of treacle, will be found in the vessel. This is pure meat-juice; the sap, so to say, of the flesh. It is then poured off, leaving behind all the fibrous remains.

As a proof how entirely every nourishing particle is extracted from the beef by this process, no animal will eat the residue—the greaves, as it may be called; and if a dog be forced by hunger to feed upon it, he will starve.

One pound, then, of this preparation contains the essence of thirty-two pounds of beef. From a smaller quantity of meat this amount of essence is not to be obtained; and whoever professes to do so *must* have with his extract something more than the pure juice. Unless *quite pure,* it is liable to spoil; moreover, the volume is increased at the same time that its value is diminished.

A remarkable circumstance is, that this extract of meat, unlike meat itself, will keep for years without undergoing any change. I have seen two potsful, ten years old, which were as good and fresh as though of yesterday, and they had only been covered with a piece of writing-paper in the same way as is done with a jar of preserves. From the following circumstance, indeed, it would almost seem that the extract possessed an anti-corrupting power. The two pots of ten years ago had been kept in a cellar where, owing to the damp of the place, a furry mould had formed about them, and even on the edges inside. But wherever the slightest particle of this essence had touched the earthenware pot, there was no trace of mouldiness.

Here, then, we have an essential requisite, the certainty of the preparation not changing or becoming unfit for use. Nor is any peculiar care or mode of storing necessary in order to ensure this. Whether in dry or damp places, it remains the same. One quarter of a teaspoonful of the juice that for ten years had been loosely covered with but a sheet of paper, tasted, when mixed with hot water and a little salt,* like delicious beef-tea made that same morning.

Another equally essential quality is its compendiosity. In a tin case 10lb. weight, the essence of 320 lb. of meat is combined.

It may be thought that the gelatine tablets, which when dissolved in water form a sort of broth, are in reality the same as the meat-essence here spoken of. But this would be a totally false supposition. The tablets are made from the tendons and muscular fibre, and contain much glue—gelatine—without any nourishment whatever. After a time, a sick person fed on such preparation gets disgusted; as was the case with the patients in the Hotel de Dieu at Paris.

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* The exact proportions are, one-eighth of an ounce of meat-essence, and one-sixteenth of an ounce of common salt. This makes a breakfast-cupful of beef-tea.

Moreover, the jelly of which this mess is composed weakens the stomach, and deranges the organs of digestion.

Now the use of pure meat-juice has just the contrary result. It is not only so agreeable to the taste, that persons who have taken it in their invalid state continue to do so after perfect recovery, but it appears to have a wonderfully restorative influence, by assisting the digestive organs in their functions instead of oppressing or weakening them. It seems to act in the same way as the gastric juice—to help to digest food and cause its assimilation with the body. Indeed, a French physician found the residue of gastric juice to be very analogous to pure essence of meat. He further tried to discover the cause of this power to further the assimilation of food; but as there is a boundary beyond which it is vain for human investigation to go, his efforts led to nothing. We know, for example, how meat may be produced, and the various forms in which it is present; but as to its innermost nature, how it is that what is hot imparts warmth, that is a secret which no analysis will explain or enable us to understand.

It is not at all improbable that the similarity between meat-essence and its effects, and gastric juice and its functions, should produce that exhilarating restorative influence which the former invariably effects on the exhausted and suffering.

The essence contains, too, phosphate in large quantities, and the same lactic acid which is secreted by the muscles in all bodily exertion.

Following the method prescribed by Liebig, this extract has been prepared for some time at the Royal Pharmacy, Munich, under the superintendence of Professor Pettenkofer. But naturally it cannot be furnished at a less price than the selling price of meat in the country; and it therefore is used—with but few exceptions—only by those who take it medicinally. From 128 lb. of beef four pounds of extract are prepared weekly, and dear as it is—two shillings an ounce—the demand for it is so great that the quantity made is always found insufficient. Even at this high price, high at least for Bavaria, many poor families for whom it was once prescribed continue to buy it; not any longer as a restorative, but for use in the kitchen.

For this latter purpose it will find many a purchaser if Herr Giebert succeeds, as he hopes to do, in his plan of furnishing it at a price not exceeding 7*s.* 3*d.* per lb. It will cause a revolution in Continental cookery, in which the daily plate of soup is considered indispensable. The meat which now is boiled, will then, in many families, be roasted; and the soup will be made with a spoonful of the extract, and the usual addition of vegetables. This would be a gain in every way. Not only is roast meat more palatable, but it contains also a greater amount of nourishment than that which has been boiled in order to procure soup. When a good soup is thus obtained, the meat loses its amalgamating properties. They have been extracted from it.* The usual *bouilli* of the Continent, which is mere fibrine, supports and supplies strength only because the soup is eaten with it. Without the soup it would afford very imperfect sustenance. Herein lies the great difference between boiled and roasted meat. The Englishman eats his soup *in his roast beef.*

The beneficent uses to which this meat-essence may be applied are manifest. For the sick, as already has been stated, it is an especial Godsend. Even in cases of gastric fever, when, from the nature of the disease, the stomach is peculiarly unfitted to support food, to digest and assimilate, this pure juice is found grateful, exhilarating, and strength-giving. To the weak stomach it seems rather like a congenial essence akin to its own nature, than a foreign element or an extraneous thing; a circumstance which might be thought to prove the truth of the French chemist's assertion more strongly even than his analysis.

The use of this meat-essence in the military hospital at Munich has brought to light a fact important to the physician. It has been found that the convalescence of patients who have been suffering from typhus is accelerated in a wonderful degree by the introduction of this meat-juice as an article of their diet, so that, dear as it is, calculation has proved its use in such cases would be profitable, if on economic grounds only; so quickly do the men recover their strength and become fit for duty.†

On the battle-field this extract, so portable and so easily made into warm bouillon, would be a boon indeed. We all remember how highly the refreshing cup of tea was prized which, by Miss Nightingale's thoughtfulness, was given to the wounded men in the Crimea as they were borne away from the battle-field. A draught of the refreshing beverage upheld the fainting strength of many a poor fellow who, but for that kindly help, would have sunk long before he reached the hospital.

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* This has been proved by Liebig. Dr. Magendie also found that a dog fed on boiled meat only, *without the soup,* died of hunger.

† How palatable the men find such beef-tea is shown by the circumstance that when the doctor says to a patient, "Well, I think you are now well enough to return to your usual diet," and consequently to leave off the meat-essence, the answer invariably is, "I beg you, sir, have the goodness to let me have it once more." ("Ich bitte Sie, Herr Doctor, schreiben Sie es mir doch noch einmal auf!")

A fire and an iron kettle and some salt are always to be had; and these, with a tin case of the precious meat-juice, are all that is needed to support the failing life of men who are battling with their agony. Such a restorative might almost claim to rank with that nepenthe of modern days, the blessed chloroform.

The French physicians, MM. Proust and Parmentier—the latter chief of the medical staff of the French army—assert that, mixed with a little wine, its vivifying effect on the wounded is truly marvellous.

In a case of violent hæmorrhage, followed by extreme exhaustion, it was given with all possible success. At first two cups of weak bouillon were taken daily, then some a little stronger—one-eighth of an ounce of extract to one pound of water—and for fourteen days this was the sole nourishment. Though gastric fever had supervened, the patient recovered strength, and in six weeks was able to walk a little. The veins under the eyes, which had been quite emptied by the excessive loss of blood, recovered their former state, and a healthy hue took the place of the former livid pallor.

We have of late been unremitting in our endeavours to lessen the horrors and sufferings which war inevitably must cause, to do our very utmost to preserve in health those who go forth to maintain their country's honour, and to nurse tenderly, that we may save, those brave fellows whose frames have been shattered by bullets or disease. An additional means is now ours to ameliorate and to soothe.

How invaluable, too, for the sick on ship-board, whose recovery fresh meat would so greatly further! But to the sailor as yet strong and well it would also prove a preservative against illness; for it has been discovered that it is not salt which is the cause of scurvy, so prevalent during long voyages, but the absence of a great portion of the assimilating particles of the meat, two-thirds of which are lost in the brine. It is the want of creatine and creatinine, and phosphate of potash, and lactic acid—of that, in short, which may be called food for the nerves—which produces scurvy in men who feed on salt meat for any length of time. Supply such meat with some of its removed juice, and it ceases to render scorbutic. Even old junk may still be given to a crew, and would prove nourishing and wholesome, if to half a pound of meat per man one-eighth of an ounce of the meat-juice were added, either as sauce or mixed with vegetables.* The pristine nourishing quality of the beef is thus restored to it. But as on board ship there is always a store of peas, beans, and other pulse, these might simply be boiled, and a small quantity of the meat-essence added to them. This would form a change of diet, and be both palatable and nourishing. For—and this important fact must not be lost sight of—by adding this meat-juice to vegetable diet, potatoes, beans, &c., many of the properties of strengthening, exciting animal food are imparted to it, so much is the diet ameliorated.†

In fortresses it will be equally valuable; for not only does it keep any number of years—up to ten at least, the results have been perfectly satisfactory; but, in case of a hasty evacuation, it would be possible to carry away what was in store, instead of leaving it to the enemy, as would be the case with objects of larger volume, and consequently less portable. The meat-biscuit used by the North-pole explorers is an excellent preparation.

The adoption of the essence in hospitals, even in time of peace, would have this advantage, that the patients for whom it was prescribed would get what was intended for them. At present, in many instances, the good strong soup is appropriated by the attendants, while the weaker decoction only reaches the invalid.

Even where epidemics rage from insufficiency of nourishment, or from unwholesome food, this extract will serve to alleviate the misery; for, if not within the reach of the wholly destitute, its cheapness will always enable the charitable, as well as the Government, to do an immense amount of good with sums comparatively small.

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* Liebig has shown that in salted meat the phosphate of potash leaves it, and common salt takes its place. The quantum of potash which all fresh meat has, and which for the purpose of nutriment is absolutely necessary it should have, is wanting, therefore, in such brine-saturated provisions. Our vegetables contain much potash; hence their efficacy in cases of scurvy.

† These are Baron Liebig's words on the subject: "In a certain sense bread possesses the nourishing power of meat, but in the juice of flesh are contained a number of substances, exercising a peculiar effect on the organisation, and which belong, as its specific character, to animal food. These substances, wholly wanting in a vegetable diet, are the component parts of extract of meat; and hence it will be understood that with its addition, they impart to vegetable food the effect of animal nourishment. A mess of bread, water, and salt, is something very different from a porridge made of broth, salt, and bread. One pound of extract of meat contains the soluble matter of 30lb. of flesh free from all fat; and if boiled with a few slices of bread, potatoes, and a little salt, is sufficient to make broth for 128 men in the field, and of a strength which is not to be obtained in the best hotels."

Though soup may be made from bones only, containing as they do a certain amount of gelatine, it is very different from that produced by the boiling of meat. The presiding physician of the Hospital of St. Louis at Paris adopted the use of bones, which, when broken and allowed to simmer for a long time, yielded a bouillon of seemingly sufficient good quality. The patients, however, suffered from this fare; they not only soon grew tired of and disliked it, but the glue it contained deranged their digestion. They neither gained strength nor flesh; but, on the contrary, grew emaciated. Hence it would seem that in fresh meat are virtues which no other substance can supply.

When this essence of beef which is here described is kept for a time, small crystals of creatine form in the syrup-like fluid. They are not perceptible to the eye, but on the tongue their presence is detected, just as in tasting a liquid saccharine matter the crystals of sugar which it contains are felt on the lips. By a chemical process these may be obtained apart; they are of snowy whiteness and brilliancy, and are in appearance not unlike Epsom salts.

Since the above was written, several cases of essence of meat have been received from Monte Video. A cup of beef-tea made with half a spoonful of the extract is quite delicious. It has a peculiarly fine, delicate flavour. With the consignment came also some extract of the flesh of sheep, and this is so excellent that there are some who even think it preferable to that made of beef. Herr Giebert has his apparatus in full working order, and will be able to furnish 5,000 lb. of essence per month.

Within the last few weeks a confirmation of what is here said with regard to the so-called *consommé*, has been furnished by the preparation of a French speculator. In tin cases bearing the word "Specialité," as well as "Approuvé par la Société Impériale de France," a liquid called "Osmazone glace" is offered for sale, and purporting to afford 40 cups of bouillon per kilogramme. The said fluid is so disgusting that it is hardly possible to imagine that any one could be prevailed on to put a spoonful of it in his mouth. The smell is like that of a stale glue-pot, when the animal matter it contains has grown fetid. Why the manufacturer should sell it in a liquid state, packed in soldered canisters, is quite unintelligible; for by evaporation it is easy to reduce it to a mass in no wise distinguishable from joiner's glue.

As it comes from afar—from Rio Grande, where it is probably made from the feet and sinews of the slaughtered animals—people fancy it must be valuable.

Genuine extract of meat is permeated with crystals of creatine, one of the essential components of the juice of meat; and if treated with cold water these crystals are left behind mixed with phosphate of magnesia, and then, too, the half of the weight of the dry extract of meat is soluble in alcohol, and the residue left is very different from gelatine or glue. From "Osmazone glace" treated with alcohol, nearly 90 per cent. remained unsolved, and its residue was not distinguishable from common glue. It does not seem that any meat was used in the preparation of this nauseous stuff.

ON SPONGES.

BY ROBERT PATTERSON, F.R.S.

SPONGES, especially the sponges of commerce, form the subject of the present paper. It is intended to notice, though very briefly, some of the opinions formerly entertained of their nature and affinities; to state the views which now find acceptance among naturalists; and then, regarding them as articles of trade, to say something of the mode in which they are collected, and the extent of the commerce to which they give rise.

What is a sponge? Is it more properly an animal or a vegetable production? seem to be questions, respecting which a great variety of opinion has prevailed. If we go back so far as the time of Aristotle, we find he speaks of it in one place as a stationary or rooted animal, but elsewhere he seems to regard it as a production intermediate between the animal and vegetable kingdoms, "for Nature," he says, "passes continuously from things without life to animals, through things which live yet are not animals, so that they appear to differ very little when viewed in connection."

Leaving those speculations of the ancients, and coming to more modern times, we are told by Geralde, author of the "Herbal," published in 1578, "There is found growing upon the rockes near unto the sea, a certain matter wrought together of the fume or froth of the sea, which we call sponges."

Ray, in 1686, considered them as of all marine vegetables the most nearly related to the fungi, being composed of a substance like compacted wool, perforated with tubes and holes, and covered over with a certain membranaceous mucilage.

Linnæus at first placed sponges among the algæ; but in the twelfth edition of his "Systema Naturæ," published in 1767, they were classed among Zoophytes.

To Dr. R. E. Grant, the eminent Professor of comparative anatomy and zoology in University College, London, we are indebted for those "Observations and Experiments on the Structure and Functions of the Sponge,"* that gave a higher and more philosophic interest to the study of their nature and affinities. He became convinced that they are not produced

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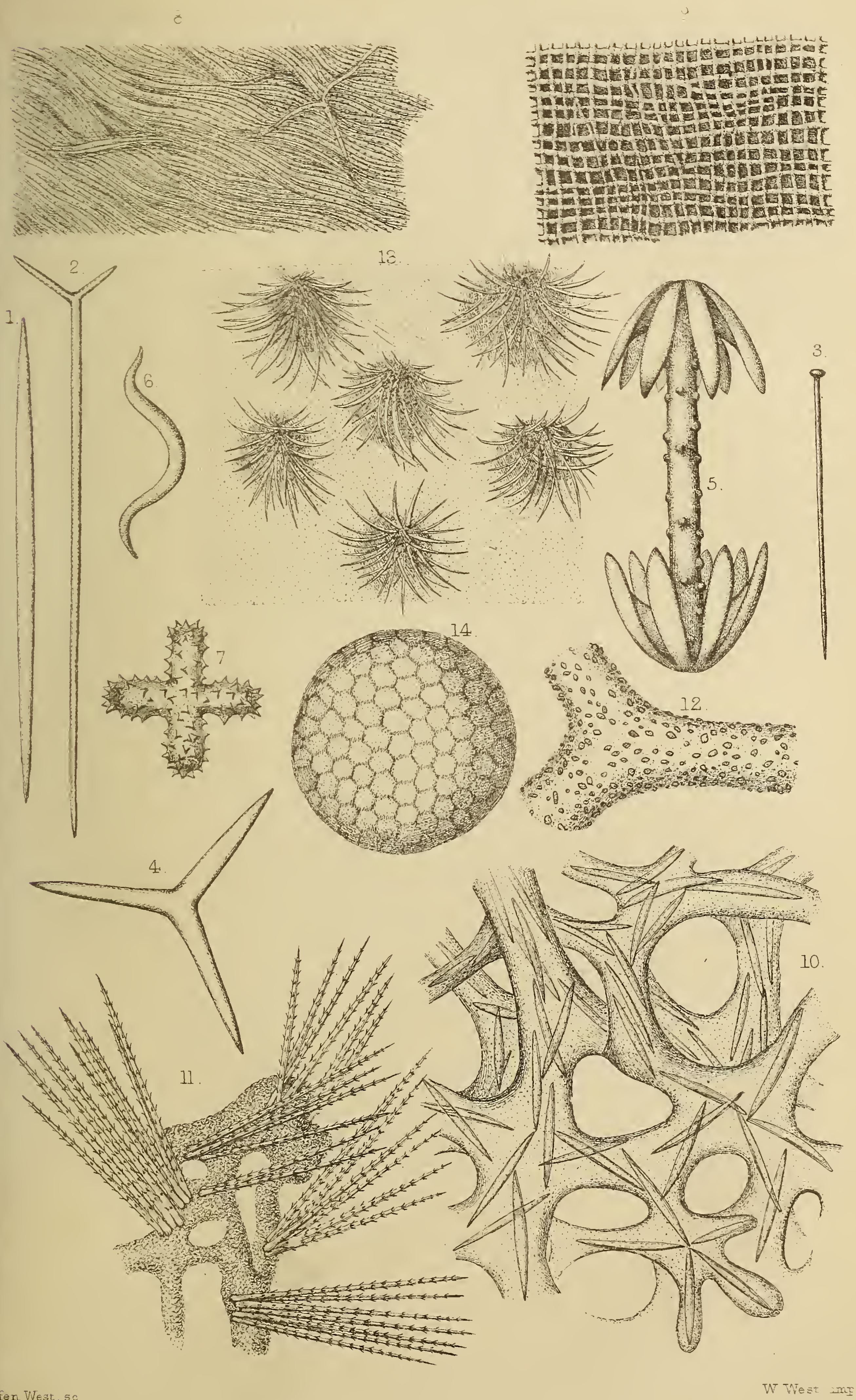
* *Edinburgh Philosophical Journal*, vol. xiii., xiv.

Plate XII



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Sponge Structure.
(after Bowerbank.)

BRITISH MUSEUM NATURAL HISTORY.

by polypes, but are, as Ellis had shown, animals of a peculiar kind, destitute of any sensible motion. The surface of the sponge mass is covered with small pores, which imbibe water; this circulates in a continuous current by means of internal canals, and is driven out with considerable force through the larger orifices or *Oscula*. The water entering by the pores is pure and untainted, that which is driven off is mixed with opaque feculent granules. Dr. Grant having put a small branch of a common species of living sponge with some sea-water into a watch-glass, and placed it under a microscope, thus describes the appearance he then witnessed:—

> On moving the watch-glass, so as to bring one of the apertures on the side of the sponge fully into view, I beheld for the first time the splendid spectacle of this living fountain vomiting forth, from a circular cavity, an impetuous torrent of liquid matter, and hurling along, in rapid succession, opaque masses, which it strewed everywhere around. The beauty and novelty of such a scene in the animal kingdom long arrested my attention, but, after twenty-five minutes of constant observation, I was obliged to withdraw my eye, from fatigue, without having seen the torrent for one instant change its direction, or diminish in the slightest degree the rapidity of its course.

The researches of Professor Grant were those that first gave to naturalists a correct idea of the inhalent and exhalent powers of these singular bodies, and the details given by him have had their accuracy confirmed by all who since then have studied the sponges in a living state. Hence it has been justly remarked that "Dr. Grant has, in truth, proved himself to have been, in regard to the aqueous circulation in the sponge, what Harvey was to that of the blood of the higher classes of animal life, the first to discover and to publish the true mode of the circulation of the water in the animal."*

MM. Audouin and Milne Edwards, after an attentive study of the sponges indigenous to the shores of France, confirm Dr. Grant's statements relative to these singular productions, which, to use the words of Dr. Johnston, "certainly possess an animal life,"—"vivent d'une vie tout animale,"—but to which, he says,† "the anatomist may be tempted to refuse animality, since he cannot distinguish in them any organ by which it is characterized." The names of distinguished naturalists, both Continental and British, henceforward appear, as giving in their adhesion to the view of the animality of sponges. But some whose scruples are entitled to respectful consideration still held back.

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* "Monograph of the British Spongiadæ." Bowerbank. Vol. i. p. 116. Ray Society, 1864.

† Preface to "British Sponges," p. 57.

Among these may be mentioned Professor Owen, who said, "that if a line could be drawn between the animal and vegetable kingdom, the sponges should be placed upon the vegetable side of the line;" and, acting on this conviction, he did not include them in the groups enumerated in his "Lectures on the Invertebrate Animals," published in 1843. The learned author of the "History of British Sponges and Lithophytes" (1842) does not hesitate to speak of them as "true Zoophytes;" but in the preface to that work he expresses himself with characteristic caution. "The class may be said to occupy at present a piece of debateable land, lying between the confines of the two organic kingdoms,—too poor and barren to be an object of contest with the subjects of either, and readily relinquished to the occupation of any eccentric borderer who may find his pleasure in cultivating an intimacy with its rude tenantry." These words, from the pen of Dr. Johnston, come naturally from one who was an inhabitant of the old border country, and lived in the good town of Berwick-upon-Tweed. There he exercised the laborious profession of a country practitioner, cultivating with ardour his natural history pursuits, and ever making fresh accessions to his knowledge of the antiquarian and legendary lore of the district. In tracing the history of opinion as to the nature of sponges, we have freely availed ourselves of his labours. The knowledge of their organization has been greatly increased since the publication of his volume in 1842, and is certain to be much further augmented; but the student will still gladly turn to the writings of Dr. Johnston for an array of facts collected with vast research, skilfully condensed, and arranged so as to admit of easy reference. Such a record, "figuring the nature of the time deceased," appeals to our common humanity, and has an interest over and above the scientific facts and opinions which it embodies.

We do not profess at present to go into minute details regarding either the structure or physiology of sponges, and we therefore pass by a valuable paper on the "Anatomy of the Genus *Tethya*," written by Professor Huxley,* and giving promise of the eminence which he has since attained; also some excellent communications by Mr. Carter, on the sponges in the fresh-water tanks at Bombay.† We do so because our space is limited, and we wish to quote some of Dr. Bowerbank's observations on the vitality of sponges,‡ a subject to which some degree of popular interest is attached.

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* "Annals Nat. Hist.," vol. vii. Second series, 1851, p. 370.

† Idem, vol. xx., 1857. Third series, vol. iii., 1859.

‡ "On the Vitality of the Spongiadæ." Reports of British Association, 1856–1857. The facts are embodied in his Paper in "Trans. Royal Society,"

The pores in Spongiadæ are, as already mentioned, the orifices or mouths through which the animals imbibe their nutriment, and receive the supply of water, which, in their case, is the equivalent of a supply of pure air for respiration to an animal living on land. In some of the more highly organized genera, there is good reason to believe they are permanent organs. But not so in others. The opening and closing of the pores in *Spongilla fluviatilis* has been described at length. "Each operation is commenced and terminated in less than a minute; they are perfectly dependent on the will of the animal, and in neither case are they simultaneous, but follow in irregular succession, in accordance with the necessities of the animal; and when once closed, they do not appear to ever open again in precisely the same spot." "No cicatrix remains for an instant after closing; no indication of the spot where the opening is the next moment to be effected."

"The oscula are the fæcal orifices of the sponge. They are permanent organs, and are capable of being opened or closed at the will of the animal, and are subject to a considerable amount of variation in size and form, in accordance with the variations in the actions of the sponge."

Such of our readers as may be spending a little time at the seaside next summer, may possibly have the opportunity of collecting some marine sponges from the rocks, and watching the vigorous currents to which they give rise when placed in shallow vessels of sea-water. If so, they may perhaps find, to their surprise, that two or three specimens of the same kind of sponge, placed in gentle contact with each other, will, within twenty-four hours, be united firmly together; and on the ensuing day the union will be so complete that no trace of the junction can be detected. But not so if the specimens belong to different species; then neither contact nor compression will compel them to unite. The following experiment, recorded by Dr. Bowerbank, we have more than once repeated, with some slight modifications.

Seven larger sponges, which he had separated by cutting into halves, and then replaced in water with the divided parts again in close contact, were all found firmly united at ten o'clock on the following morning; and next day, so early as 10 a.m., the reparation of the subjects of the above experiment was so complete as to obliterate all traces of the separation in some of them. In other cases he "cut the same species of sponge into three pieces, and reversed the position of the middle piece of each, so as to render the sections unconformable; but

1862, and in vol. i. of his "Monograph of the British Spongiadæ." Ray Society, 1864.

this reversal of position, when the surfaces were brought into close contact, did not seem in the slightest degree to retard the healing process, or to render the adhesion of the pieces less firm than when placed together conformably."

Such phenomena are so different from those which we are accustomed to associate with animal existence, that the question may very naturally be asked, "If sponges be animals, what is the place assigned to them by zoologists?"

It is one of very humble rank. Naturalists have now separated from the *Radiata* of Cuvier the minute gelatinous creatures, in which animal life is supposed to appear in its very simplest aspect; hence the term *Protozoa*, by which the sub-kingdom is designated. Each humble organism is apparently homogeneous throughout, and every part seems capable of performing every possible duty that the habits of the animal require. The *Amœba* may be taken as an example. The sponge is an aggregation of *Amœbæ*, endowed with the power of secreting a framework or skeleton, which differs to a remarkable extent in the leading groups. In the sponges in domestic use it is principally composed of a substance termed Keratose. The soft elastic substance which we use in the bath or at the toilet, and term a sponge, is therefore the skeleton secreted by an aggregation of gelatinous animalcules.

The Sponge Trade.—We have had our attention directed to the sponge as a living animal; we have now to consider it as an article of trade. We turn, therefore, from the rain and mists which at this season (November) surround us, and transport ourselves in imagination to the bright skies and sunny waters of the Ægean, for there the best sponges are procured. To a valued friend who cruised for some successive summers in those regions we are indebted for the following particulars.

The craft employed consists of small caiques, carrying six or eight men each, and not too large to be easily managed by a pair of oars. During the season of the diving operations these boats lie about the shores at night, moored in some creek, and start off to their ground at daybreak, the crew fishing, or diving rather, until the sea-breeze sets in about noon, when they take shelter in some of the little nooks abounding on the shores of the Archipelago, and soak and stamp out the sponges, treading on them to press out the animal matter, and bleaching them in the sun. The fishery is carried on during the summer months; and it is only in nearly calm weather that the divers can work. The best sponges are procured on detached heads of rock in eight or ten fathoms water. The littoral sponges, though numerous, are unfit for commerce. The capital is usually advanced by the English merchant.

Some additional details are given in Forbes and Spratt's "Lycia," and may here be quoted.

"Sponges are abundant in the Lycian Sea. The more valued kinds are sought for about the Gulf of Macri, and along the Carian coasts and the opposite islands. Rhodes is the seat of one of the depôts for the sponges of commerce. The species which live immediately along the shore near the water's edge, though often large, are worthless."

"Many species are made up of interlacing bundles of spiculæ with animal matter." "The larger kinds are not found deeper than thirty fathoms, and most of them within a third of that depth. A few small species live at very great depths, and one was taken alive in the Gulf of Macri, in one hundred and eighty-five fathoms water. The colour of the living sponge is a dull bluish-black above, and a dirty white beneath."

Sponge is the great article of export from the Ottoman archipelago, and the collection and preparation of it gives occupation to many thousand people, and influences the whole social economy of the district. For example, from May to September, only old men, women, and children are to be found in the island of Syra, all the able-bodied part of the male population being at this season at the sponge fishery, as it is popularly termed.* The people of the island of Lemnos form an exception to the remark just made; for, although sponges are plentiful on the coast, the inhabitants do not "fish" for them.†

The sponge-divers carry round the neck a hoop, to which a netted bag is attached; into this the sponges are put as fast as they are gathered. In deep water they make use of a rope, made sufficiently heavy, by means of a stone, both to guide them to the spot where they are to work, and to aid them in their ascent.

The Greeks of the Morea, instead of diving, make use of a trident with cutting recurved prongs, and furnished with a pouch or net. This mode of fishing tears the sponge, which therefore sells at a low price.

Mr. Campbell, the British consul at Rhodes (1859), after referring to the increase of the sponge trade, states that of the 600 boats, manned by 4,600 men, engaged that year in the sponge-fishing, 70 were employed on the coast of Rhodes, 150 on the coasts of Candia, 180 on the coasts of Syria, and 200 on the coasts of Barbary.

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* "Technologist," vol. i. p. 17.

† Consular Report, 1859, p. 507.

It would seem, from Mr. Campbell's report, that the men employed in the laborious but profitable avocations of sponge-divers are at times subject to very grievous exactions from those in authority. Prior to the year just mentioned, the sponge-fishery on the coast of Rhodes had declined, but this year it was resumed, seventy boats having arrived for that object. The Governor-General immediately established a duty of 20 per cent. on all sponges taken on these coasts, and it was not until the divers threatened to go elsewhere that it was commuted for a fixed sum of £3 on each boat.

A duty of 20 per cent. is levied on all sponges taken on the coasts of Candia, but the divers are gradually leaving that island for the coasts of Barbary, where no duty is exacted, although their boats have to be carried there in vessels and brought back in them to their respective islands at great expense, whereas they could proceed to Candia in their own boats. It is not so much of the duty itself that the poor people complain, but of the irregular and rapacious manner of its exaction.

There has been a great advance of late years in the prices at which the various qualities of sponge are sold, arising from the increased demand and the consequent competition among buyers. The following table* shows the prices in successive years; they are given in piastres, which may be estimated at 2d. each. The prices are quoted per oke of 2¾ lb.; but, in point of fact, it is not often now that they are sold by weight in the Archipelago, in consequence of the numerous frauds engendered by the practice of filling the sponges with sand. They are, however, re-sanded by the sponge merchants as a preliminary to shipment to foreign markets.†

	Fine.	Common.	Coarse.	Total of the Amounts paid in British Currency.
1852	220 piastres	40	15	—
1857	300 „	65	35	£81,000
1858	325 „	100	30	90,000
1859	365 „	115	33	107,500
1860	420 „	130	35	141,500
1861	450 „	120	60	111,000
	fell to 300 „	80	40	

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* Mr. Campbell's Consular Report at Rhodes, 1861.

† In London, the sponge merchants sell the cases unopened, and with a large quantity of sand in them, as imported. The sponge dealers assort the various qualities and sizes, clean the sponges more or less perfectly, and sell them at corresponding rates. An extremely high price is occasionally given for small parcels of superior toilet sponge. We were told of one instance, in which a purchaser from Paris agreed to give 10s. 6d. per piece for 114 pieces, each about the size of a breakfast-cup, or a little larger, and carefully selected

It will be noticed that the fine and also the coarse qualities of sponge had attained, at the beginning of 1861, a price unprecedented; and this was followed by a great and sudden collapse.

The following curious table * shows not only the countries to which the sponges are sent, but the proportionate quantity of each of the three qualities sold. It is made out on the supposition that the entire "crop" for 1861 was divided into thirty-six parts, and thus distributed:—

Countries.	Fine.	Common.	Coarse.	Amount of Crop sent to each Country.
Great Britain	7/12	2/12	4/12	13/36
France	3½/12	8/12	4/12	15½/36
Austria	1/12	1½/12	3/12	5½/36
Constantinople	½/12	½/12	1/12	2/36

It will be seen from this table that the two principal markets for sponge are England and France. The former is the great purchaser of the finest quality, the latter of the second quality. The refuse of the fine, the common, and the coarse sponges is sent to Constantinople.

The following figures, taken from official returns, show the total quantity and declared official value of Turkey sponge imported into the United Kingdom in four consecutive years.†

1855	329,985 lb.	£140,164
1856	313,287 ,,	172,308
1857	318,676 ,,	164,650
1858	287,681 ,,	157,751

The Bahama Sponge Fishery.—A very inferior description of sponge is procured about the Bahama banks and the coast of Florida. The sponges are torn from the rocks by means of a strong two-pronged fork, fixed to a long pole. They are buried in sand for a week or ten days, to get rid of the black animal matter; they are then placed in enclosures of about twelve feet square, formed of stakes driven into the mud along the shore, and are there soaked and washed. When thus cleaned they are dried, pressed, and made up in bales of about 300 lb. each. From 1,000 to 1,500 of such bales are annually exported. The best sells for about one shilling the pound, and the second quality at ninepence.‡

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by himself from ten cases of finest Turkey sponge. When well beaten, and perfectly free from sand, 28 of these pieces weighed only one pound; so that in this instance fourteen guineas were given for a pound of sponge!

* Mr. Consul Campbell's Report on the Trade of Rhodes, for 1861—published 1862, p. 380.

† "Technologist," vol. i. p. 20.

‡ We are indebted for this information to an article in the "Technologist," by the Editor, vol. i.

A French periodical contains a suggestive article "Sur l'Acclimatation des Eponges dans les Eaux de la France et de l'Algérie," by M. E. Lamiral. "We are," he says, "ignorant of the exact duration * of life in sponges, and also their rate of growth, but we know that we can return and fish for them in places where only three years before they had been almost extinct. If sponges were more abundant and less costly, the uses of them would increase." Even as it is, the consumption goes on increasing, and the production does not keep pace with the demand. In every part of the Mediterranean the fishing for sponges is carried on without regard to its future continuance. The author, therefore, proposes that steps should be taken to naturalize sponges on the coasts of France and Algeria, round the coasts of Corsica and Hyères, and in certain lakes or salt pools adjacent to the Mediterranean.

The only difficulty is in the "transplanting" of the sponges from Syria into Algeria or France. The temperature and composition of the water is favourable, and the change northward would be in favour of the quality of the sponge. As regards the removal, he remarks that a man properly equipped and supplied with air can be put into free communication under water with the objects that surround him. He can select the most suitable blocks of stone on which sponges are growing, place them in boxes pierced with holes, and tow these to the coasts where he wishes to place them. Certainly, in the following year, the sponges would propagate in their new country.

The gemmules, or as he calls them the larvæ, could be collected in great abundance in spring, and transported rapidly from Syria to Algeria.

The "Nouvelles Annales de la Marine," Paris, 1861, approves of the above proposal. Should the French Government attempt to carry it out, we dwellers in more northern regions shall look with much interest to the results.

For structure of sponges, see plate.

EXPLANATION OF PLATE XII.

Figs. 1, 2, 3, 4. Spicules of the skeleton; 5. Defensive spicules; 6. Spicules of membranes; 7. Retentive spicules; 8 and 9. Membranous tissue; 10 and 11. Keratose fibrous tissue; 12. Fibre of Bahama sponge with embedded ova; 13. Group of ova or gemmules; 14. Large gemmule.

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* Bulletin de la Société Impériale Zoologique d'Acclimatation, 1861.

THE PHYSICAL PHENOMENA OF OTHER WORLDS.

BY ROBERT HUNT, F.R.S.

> Ye stars! which are the poetry of Heaven—
> *   *   *   *   ye are
> A beauty and a mystery.

THE lights which spangle the blue robe of space have, through all time, exerted a strange, though varying, influence on the minds of men. The uncivilized wanderer has ever acknowledged, in his own wild way, the existence of a mysterious power in the stars; and under their mild influences he has almost forgotten his savage nature. The more civilized dwellers within those cities on which a true philosophy had not yet shone, clothed every orb with mystic forces, ever active for good or for evil; and to them "the stars in their courses" were the rulers of their destinies. The "Poet's eye, with a fine frenzy rolling," pierces the vault of heaven; in ecstasy he wings his way from star to star, till his mind, oppressed with the immensity of worlds, confesses its weakness in proclaiming them "a mystery." The philosopher, however, who has been trained in the school of inductive science, notes the peculiar characteristics of terrestrial powers, and each fact established becomes to him a new bar on the ladder, by which he tranquilly ascends to the examination of celestial phenomena. Thus science has taught us something respecting the nature of A SUN, and is advancing the human mind still further into space, to open to us some of the mysteries of A STAR and the wonders of a *nebula*. Many a man, gifted with no mean powers, and anxious to witness the advance of his kindred in the paths of goodness and truth, expresses an honest fear lest the darings of science should prove dangerous to the teachings of his school. The presumptuous flights of erratic minds are ever fraught with danger to themselves and others; but the cautious progress of the trained observer leads us onward, in safety, to the full blaze of Truth, and upward, to a more exalted appreciation of the powers of the Almighty Intelligence, who binds "the sweet influences of Pleiades," or looses "the bands of Orion" —who brings forth "Mazzaroth in his season," or guideth "Arcturus with his sons."

We look up into the skies on a clear night, and observe the thousand discs which shine down upon us. We mark, it may be, those planets of our own system which are visible, and meditate upon their positions in space, relatively to the Sun, as the centre around which they move, and their relations to our Earth, as one of their fellows. A little thought convinces us of a striking fact. No two of the planets are alike: size, density, time of rotation, and arrangement of orbit differ in each. Our Earth has one moon, Jupiter four, Saturn seven, Uranus six, Neptune two; and then Saturn moves with splendid girdles of light around him. Each one of those bright worlds receives from the Sun the same radiant forces which flow to our Earth. We have learnt that where there is solar light, there is organization; consequently *we know* that every planet is a world, upon which organized creations exist. The year of Mercury may be but equal to three of our months, while that of Neptune extends to 164 of our years. The seasons may—certainly do—greatly vary; Jupiter, probably, has but little vicissitude; but may not Saturn, in the shadow of his rings, have a winter of many years' duration? Notwithstanding this, we are compelled to believe that the solar rays are shot forth into space to do the work of Life; and the very fact that the planets receive those solar energies and reflect them, as terrestrial bodies do, is sufficient to prove that they are covered with organizations, vastly different, it may be, from those on Earth, unless we can believe in the creation of a huge machine equal to the generation of enormous powers, which are wasted in merely lighting up of empty worlds.

The observer of the heavens passes beyond the planets, and he notes those stars of the first magnitude glittering with fulness of light, and then such as are less glorious, until the power of unaided vision fails to recognize a point of light, and is conscious only of, what we may call, a luminous haze. He takes, to aid him in his survey, the best telescope; a new sidereal system bursts upon him; and he finds "that the number of the stars may be really *infinite,* in the only sense in which we can assign a meaning to the word." Here, too, he now discovers a vast variety; not only does he see that one "star differeth from another star in glory," but he is surprised to find stars as varied in colour as are the flowers of the earth—purple and orange, blue and yellow, red and green suns shining forth in space. He becomes aware of astral systems which, as Herschel says, "convey the complete idea of a globular space filled full of stars, insulated in the heavens, and constituting in itself a family or society apart from the rest, and subject only to its own internal laws." He also learns that there are twin worlds, one of these being often a self-luminous sun, and the other a dark sphere of corresponding size. But, having observed all these, he finds the space-penetrating instrument fails him; and remote in regions beyond the power of human measurement, he still is conscious of a luminous scattering, which can only be described as "star-dust."

Isolated systems of stars have been alluded to; on these a few words more. Sir John Herschel says, "In the constellation Cancer there is a somewhat similar but less definite luminous spot, called Præsepe, or the bee-hive, which a very moderate telescope—an ordinary night-glass, for instance—resolves entirely into stars. In the sword-handle of Perseus, also, is another such spot crowded with stars, which requires rather a better telescope to resolve into individuals separated from each other." These "clusters of stars" were regarded by Sir William Herschel as masses of matter revolving round a common centre, and gradually approaching by their mutual attraction; but their order, their variety, and their beauty rather tell against this hypothesis. "Among the most beautiful objects of this class"—again we quote Sir John Herschel—"is that which surrounds the star κ Crucis, set down as a nebula by Lacaille. It occupies an area of about one forty-eighth part of a square degree, and consists of about 110 stars, from the 7th magnitude downwards, eight of the more conspicuous of which are coloured with various shades of red, green, and blue, so as to give to the whole the appearance of a rich piece of jewellery." Is it not more probable that we see in such systems as those the conditions of our own solar system varied and enlarged, the power of gravitation drawing the smaller wanderers towards their central sun, while the rates of their motions are so determined—so balanced against gravitation—that they move onward "in their courses" without deviation for ever?

The Milky Way is, probably, but a mighty extension of this or some such condition. Even our own Sun and his attendant worlds may be plunged in a vast stratum of stars; amidst which it performs in independence its "internal laws" while moving with the whole—a vast sidereal ring—around some common centre. However, independently of the clusters of stars we have unresolvable nebulæ, which were well described by Halley as being like the matter of a comet's tail—a *phosphorescent vapour* or *a gaseous* and *elementary form* of luminous sidereal matter. We have endeavoured—though hastily and, consequently, imperfectly—to carry the mind of the reader from the system of Sun and planets to which we belong—through the multitudes of stars varying in their natures, from suns far more brilliant than our own Sun, to glistering, or merely glimmering particles, and on to strange luminous patches; which, although unresolvable into stars, as it was thought possible they might be—exhibit a certain degree of coalescence, which preserves those nebulous masses in a definite form. That the characters of those may be familiarized, the drawings of four nebulæ have been borrowed from Lord Rosse's Memoirs, communicated to the Royal Society. Fig. 1 is a nebula described by Lord Rosse as having a nebulous ring, seen on the flat. Of this nebula twenty-one observations were made without any symptom of resolvability, and the only change observable between the years 1850 and 1861 was that the outer luminous ring was of unequal brightness.* Fig. 2 has lateral extensions presenting the appearance of handles, which probably indicate a surrounding nebulous ring seen edgeways. No central star has been detected in this nebula.† Fig. 3 is a nebula, which with a power of 600 appears distinctly annular. The colour of its light is greenish blue; it has no star, but is surrounded with a faint external annulus.‡ Fig. 4. This is a bright, pretty large, elongated annular nebula. Lord Rosse, in his description of this nebula, remarks, "The filaments proceeding from the edge become more conspicuous under increasing magnifying power within certain limits, which is strikingly characteristic of a cluster; still I do not feel confident that it is resolvable."§ Many of the nebulæ observed by Lord Rosse and others, present forms far more singular than those which we have selected for our illustration. We may with advantage borrow a few descriptions from the ever graphic pen of Sir John Herschel.|| The nebulous group of Sagittarius consists of several conspicuous nebulæ of very extraordinary forms, by no means easy to give an idea of by mere description. One of them is singularly trifid, consisting of three bright and irregularly-formed nebulous masses, graduating away insensibly externally, but coming up to a great intensity of light at their interior edges, where they enclose and surround a sort of three-forked rift, or vacant area, abruptly and uncouthly crooked, and void of nebulous light. A fourth nebulous mass spreads like a fan or downy plume from a star, a little distance from the triple nebulæ.

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* Rosse, "Phil. Trans.," 1850, p. 507, Plate xxxviii., Fig. 15, and "Phil. Trans.," Part iii., 1861, p. 793.

† Ibid., 1850, p. 507, Plate xxxviii., Fig. 14.

‡ Ibid., 1850, p. 507, Plate xxxviii., Fig. 13.

§ Ibid., 1844, p. 322, Plate xix., Fig. 29.

|| "Outlines of Astronomy," 3rd edition, 1850.

Another nebula is described as consisting of two loops like capital Greek Omegas—the one bright, the other exceedingly faint—connected at their bases by a broad and very bright band of nebulæ. The nebula in the sword-handle of Orion is thus described:—"In form the brightest portion offers a resemblance to the head and yawning jaws of some monstrous animal, with a sort of proboscis running out from the snout." Amongst other shapes assumed by these mysterious objects no less than fourteen have been detected by Lord Rosse to give unequivocal indications of a spiral structure—they have "been found, in fact, to be composed of a series of spiral convolutions, arranged with remarkable regularity."

Let us briefly repeat the conditions observed in the vast material universe of stars which we have traversed. There are *Insulated stars*, such as Arcturus, Sirius, and our own Sun, each adapted for constituting the centres of planetary systems. There are *Binary, Triple*, and *Multiple stars, Clustering collections*, and the Milky Way. There are *nebulous stars*—the star in each case is situated exactly in the centre of the nebulosity, showing that some physical relation connects them together. There are *Planetary nebulæ*, always perfectly round in form, and of a pale uniform aspect. There are *Stellar nebulæ* and *Milky nebulosities*; these were supposed by the elder Herschel to be clusters of stars, which it was impossible to discern individually in consequence of the immense distance at which they are placed from any human observer. This profound astronomer calculated that the light from one of the faint nebulæ seen in his forty-feet telescope, must have occupied about 2,000,000 years in its passage to the earth, although traversing space at the rate of 192,000 miles in a second!

Is it possible, some one may ask, for man to determine, within any ordinary limits of probability, the physical constitution of those remote worlds? To this, the most thinking men of the day unhesitatingly reply—It is possible! Seeing that our Sun is 91,328,600 miles from us, and that we have determined, by methods described in the last number of the POPULAR SCIENCE REVIEW, many of the physical phenomena which are active upon its surface, what is there to prevent our applying the same method to determine the condition of the Dog star, which is 141,421 times more distant from the earth than the Sun is? Then, if we find that the means which we are employing to tell us something of stellar matter answers to the trial of this vast distance, what is to hinder us from interrogating in the same way the stars which are ten times more distant than Sirius; or the nebulæ, which may be a hundred or a thousand times still more remote?

Light is the winged messenger to whom we bend for information. Every one of the objects to which we have directed attention in the heavens is rendered sensible to us by its light alone. Light may be dimmed in its passage through the immensity of space; its undulations may be weakened, like the pulsations of a bell communicated to the air. They may, they do, eventually sink into rest, which, in the case of sound, is silence; in the case of light, it is darkness, or invisibility. Yet, howsoever faint may be the waves which reach the eye, they still are light rays—possessing yet all the peculiarities which have been given to them by the physical condition of the bodies from which they have originated. It has been already explained* that light results from some change in the form of matter—that this change is ordinarily combustion; but that there are other changes—"modes of motion"—by which luminous phenomena may be produced. We know, however, of no means by which light can be developed without an alteration in the condition of the material particles which are concerned in the production of luminous energy. As the light of the Sun is due to the alterations which are constantly going on in the matter of which the Sun is formed, it is more than probable that the light of the fixed stars is produced by similar disturbances. We have no reason for supposing that the planetary and stellar globes which float so beautifully in space, are in any remarkable degree differently constituted from our own Earth. We have determined that a certain number of bodies—solid, fluid, or gaseous—to which we give the name of elements, combine to form all the varieties of terrestrial matter. There may be bodies, regarded by us as simple, which are compound, and with the advance of knowledge we may discover other elements than those with which we are now acquainted. This is not important to our inquiry, which is to learn if other worlds contain any of the substances which constitute the matter of this world. It has been shown, in the papers already referred to, that when any of those elements, or compounds of those elements, are diffused as vapour in flame, they impart peculiar characteristics to the flame. It has also been sufficiently explained that by examining the flame with the spectroscope apparatus, we can determine with minute accuracy the kind of substance which is giving character to it.† Turning the same apparatus to the Sun, we find evidence which assures us that metals such as we know on this Earth exist in that great orb—and that to their combustion we owe the light, and the heat, which we receive from him. The observer turns his spectroscope apparatus, attached to the eye end of a refracting telescope, first to the moon and the planets, where, of course, we have to examine solar light after it has undergone reflexion, and secondly to the stars, shining with self-emitted light. If either the moon or the planets are surrounded with atmospheres, we might expect that the light having to pass through them, would suffer similar absorption to that which takes place in the Earth's atmosphere, and that the spectra would show lines dependent on absorptive action. As it regards the moon—the light of which we know is reflected from the *surface*—no change in the lines of the spectrum could be detected, no variation in intensity, "or the addition or disappearance of any lines. The result of this spectrum analysis of the light reflected by the moon is wholly negative as to the existence of any considerable lunar atmosphere."* The observers to whom we are more especially indebted for our knowledge on this subject, Dr. Miller and Mr. Huggins, examined the spectra of the planets Venus, Mars, Jupiter, and Saturn. Many curious and interesting conditions are noticed by those observers, but for these we must refer the interested reader to the original paper. Their conclusions we give in their own words: "The imperfect evidence which analysis by the prism affords of the existence of atmospheres around those planets, notwithstanding the high probability, amounting almost to certainty in the case of Jupiter, that such atmospheres do exist, may receive an explanation in the supposition that the light is chiefly reflected not from the planetary surfaces, but from masses of cloud in the upper strata of their atmospheres."

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* Popular Science Review, Vol. IV.—"The Source of Heat in the Sun," and Vol. I., pp. 205 and 299.

† See "On the Spectra of some of the Chemical Elements." By William Huggins, Esq., F.R.A.S. "Philosophical Transactions," vol. 154, part ii., page 139.

Adapting their spectroscope, and the telescope to which it was attached, to the necessities of their delicate inquiry, Dr. Miller and Mr. Huggins have examined about 50 stars, but they have concentrated their efforts upon three or four of the brighter stars, and of these they have mapped the spectra of two of them with much accuracy. Those, the spectra of Aldebaran and *a* Orionis are figs. 8 and 9 of our engraving (Plate XIII.), fig. 7 being a typical solar spectrum, sufficiently shown to enable any one to discover the positions of the lines. In the admirable arrangements made by those observers, the spectra of terrestrial elements could be observed simultaneously with the spectrum of the star. Thus, for example, while the eye was receiving the lines from the spectrum produced from the light of Aldebaran, spectra of sodium, magnesium, or of other metals, were formed beside the astral spectrum. By this means it was determined that the lines produced by the spectra of *sodium, magnesium, hydrogen, calcium, iron, tellurium, antimony,* and *bismuth,* were coincident with certain lines in the spectrum of the star.* Seven other elements were compared with this star without any coincidence being detected; these were nitrogen, cobalt, tin, lead, cadmium, lithium, and barium. The spectrum of α Orionis comes next under consideration. The light of this star has an orange tinge; "none of the stars which we have examined," write the observers, "have a more complex or remarkable spectrum than this." The spectra obtained from sixteen elementary bodies were observed simultaneously with the spectrum of this star. Of these, five only were found to present corresponding lines; these were the lines of *sodium, magnesium, calcium, iron,* and *bismuth.* β Pegasi exhibited a spectrum very nearly resembling that of α Orionis; two elements only have been satisfactorily determined as corresponding with lines in this spectrum; those are *sodium* and *magnesium;* and a third, *barium,* is probable. Sirius may be regarded as still under examination; four elementary bodies have been found to furnish spectra in which lines coincide with those of Sirius; viz., *sodium, magnesium, hydrogen,* and probably *iron.*

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* "On the Spectra of some of the Fixed Stars." By William Huggins, F.R.A.S., and W. A. Miller, F.R.S. "Philosophical Transactions," vol. 154, p. 413.

α Lyræ, Capella, Arcturus, Pollux, α Cygni, and Procion, have been all examined in the relations of their spectra to the lines of the metallic spectra. *Sodium, hydrogen, magnesium,* and *iron* have been detected.

Fig. 5 shows the spectra of the double star β Cygni. By a very ingenious arrangement, the spectra of those stars are formed at the same time in the instrument. The lines and bands in those spectra have not yet been measured, and "these figures must be regarded as eye-estimations only of the general features of the two spectra." In the spectrum A, the light of which is yellow tinted with orange, the absorption is greatest in the violet and the blue; for the strong lines in the orange and red, since they are narrow, would diminish in a much smaller degree the light of these refrangibilities. The yellow and part of the green are free from *strong* lines. The light of the star giving the spectrum marked B appears blue, passing, however, into green and greenish white.

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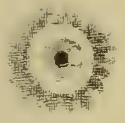
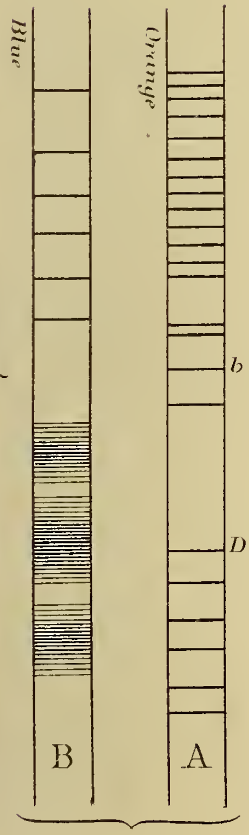
* These lines are marked on the plate as follows:—*Fe,* Iron; *Bi,* Bismuth; *Tl,* Tellurium; *Ca,* Calcium; *Na,* Sodium; *Sb,* Antimony; *Mg,* magnesium; *Hg,* Hydrogen. *N* (fig. 6) is Nitrogen; and *Ba,* Barium.

Plate XIII.

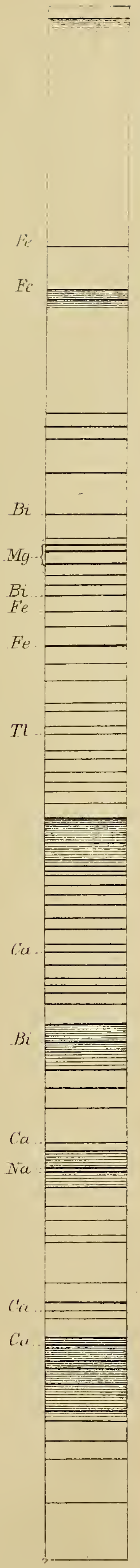


1

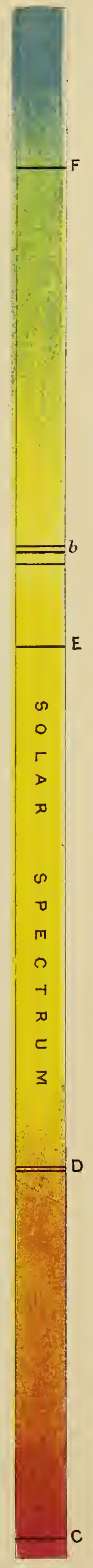
2



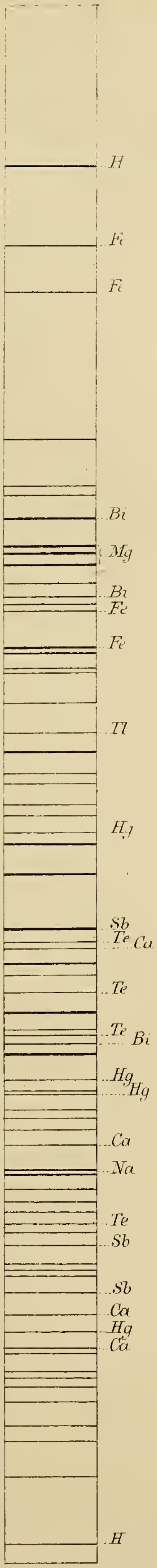
5



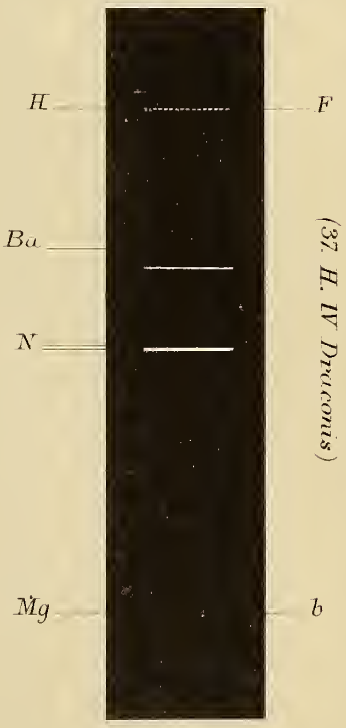
α ORIONIS.
8.



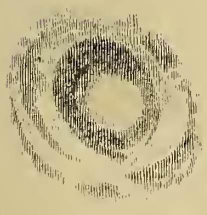
7.



ALDEBARAN.
9.



6



3

4

W. West Lith.

Spectra of Stars and Nebulæ

BRITISH MUSEUM
NATURAL HISTORY.

The more refrangible portions of its spectrum are very bright, in consequence of the absence of any strong bands. The yellow and the orange are crossed by several groups of lines.

The diversity in the colours of the stars has been remarked through all ages, but it is only of late years that the subject has been carefully examined. Ptolemy calls Arcturus, Aldebaran, Sirius, and three other fixed stars "fiery red," and Cleomedes compares Antares with the red hue of the planet Mars. Tycho Brahe especially notices the colours of the stars, and quotes the case of Sirius—in his time as in ours a white star — to prove that they change in colour. "The Grecian astronomers," says Humboldt,* "knew only red stars; while, by the aid of the telescope, the moderns have discovered in the starry vault—in the celestial fields which light traverses, as in the corollas of our flowering plants, and in the metallic oxides—almost every gradation of prismatic colour between the two extremes of refrangibility, or between the violet and the red rays." Sir David Brewster observes, that in the spectrum of every coloured star certain rays are wanting which exist in the solar spectrum. He shows that the orange-coloured star, of the double star ζ Herculis, gave a spectrum wanting a band in the red space, and two or more bands in the blue space.† An argument drawn from this was that the chemical constitution of the star, or of its atmosphere, varied in each case where a variety of colour was observed. Dr. George Wilson, whose fine mind is lost to us, and who adorned every subject to which his thoughts were ever applied, asks, "What forms of the primary matter are likely to occur in different globes?" Answering his own question, he refers to some of the rarer terrestrial elements, "which are not known to be of service in our globe;" and then says, "These seemingly useless and sparingly distributed bodies in our earth, may be the prevailing and most important constituents of other globes, and may perform functions there of which we have no conception."‡

The results which have been obtained by spectrum analysis instruct us thus far. The speculations, based upon imperfect data, to which we have referred, approach very near the truth. It has become evident to us that a similar unity of operation extends through the universe as far as light enables us to have cognizance of material objects. "For we may infer that the stars, while differing the one from the other in the kinds of matter of which they consist, are all constructed upon the same plan as our Sun, and are composed of matter identical, at least in part, with the materials of our system. . . . . There is, therefore, a probability that these stars, which are analogous to our Sun in structure, fulfil an analogous purpose, and are, like our Sun, surrounded by planets, which they by their attraction uphold, and by their radiation illuminate and energize. . . . . On the whole, we believe that the foregoing spectrum observations on the stars contribute something towards an experimental basis, on which a conclusion, hitherto but a pure speculation, may rest; viz., *that at least the brighter stars are, like our Sun, upholding and energizing centres of systems of worlds adapted to be the abode of living beings*." (Miller and Huggins.)

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* "Cosmos," vol. iii., p. 111.

† "Speculum Hartwellianum," 1860, p. 315.

‡ "The Chemistry of the Stars: an argument touching the Stars and their inhabitants." By George Wilson, M.D., F.R.S.E.

Having advanced thus far in this inquiry, which is in every way attractive to the thoughtful observer, Mr. Huggins naturally thought it an object of great importance, in reference to our knowledge of the visible universe, to ascertain whether this similarity of plan observable among the stars, and uniting them with our sun in one great group, extended to the distinct and remarkable class of bodies of which we have spoken in introducing the subject of this paper, known as *nebulæ*. Analysis by means of the prism was the means by which remarkable facts had been discovered in relation to the Sun and the stars. Why, therefore, should not the prismatic spectra of even the faint lights of the nebulæ inform us of their constitution? Selecting that class which has been grouped by Sir William Herschel as planetary nebulæ, Mr. Huggins has brought them to the test of spectrum analysis. It is not necessary, even did our space admit of it, that we should describe the results of each observation; a selection will suffice.* On the 29th August, 1864, the telescope, armed with its spectrum apparatus, was turned to a planetary nebula in Draco, described as "very bright, pretty small, suddenly bright in the middle, very small nucleus." The spectrum given (fig. 6) in our plate was obtained. The strongest line corresponding with the line always obtained in the air spectrum, and indicating *Nitrogen*, the well-known and remarkable constituent of our atmosphere. The faintest line agreeing in position with that of *Hydrogen*, and the other bright line in all probability belonging to some new element, since it does not correspond with the *Barium* line, to which it is nearest, or any other. The nebula which we have shown (fig. 1), the colour of which is greenish-blue, exhibited the two bright lines well defined. The nebula (fig. 2) gave the three bright lines very sharp and distinct. "This nebula," says Mr. Huggins, "contains very probably a small quantity of matter condensed into a liquid or a solid state." The nebula (fig. 3) gave a spectrum which corresponded with that represented; but, in addition to the three bright lines already named, a fourth bright line, excessively faint, was seen. Fig. 4 gave the brightest of the three lines well seen. The bright line looks remarkable, since it consists of two bright dots corresponding to sections of the ring; and between these there was not darkness, but an excessively faint line joining them. The light from these nebulæ was so faint that no continuous spectrum could be detected. The celebrated "Dumb-bell" nebula,* in which points of light have been observed by Lord Rosse, Otto Struve, and others, was also carefully examined. The light of this nebula, after passing through the prisms, remained concentrated in a bright line corresponding to the brightest of the three lines represented in fig. 6, and this line was ascertained, by a simultaneous comparison with the spectrum of the induction spark, to agree in position with the brightest of the lines of nitrogen. None of the bright points alluded to gave continuous spectra. By suitable movements given to the telescope, those portions of the image were made to fall on the prisms. This method of observation showed that the light from different parts of the nebula is identical in refrangibility, and varies alone in degree of intensity.

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* We must premise, that, upon examining some of the bright clusters of stars—"*clustering collections*" of Herschel—they were found to give a continuous spectrum, indicative of solid matter; not so the true nebulæ.

These remarkable researches launch us upon new fields of speculation, over which it is necessary to tread with extreme caution. Most of our astronomers have taught us to believe that the nebulæ were clusters of stars, appearing nebulous only from their extreme distances from us. In support of this view, it has been shown that as the power of our instruments has been increased, many of these objects have been resolved into stars. "The reflector of Lord Rosse has resolved, or shown to be resolvable, multitudes of nebulæ which had resisted the space-penetrating power of feebler optical instruments. Although there may be nebulæ which this powerful telescope of six feet aperture shows only as nebulæ, without any indication of resolvability; yet from inferences founded on analogy, we may conjecture that in reality no difference exists between nebulæ and clusters of stars."† In brief, it may be stated that astronomers have generally adopted the hypothesis that in the nebulæ resolvable, and yet unresolved, we have evidence of the gradual coalescence of matter into worlds. Humboldt supposes that if all the discovered nebulæ—being on the outermost and remotest strata of self-luminous worlds—known to us now were resolved into stars, the mechanical improvements in progress will eventually so increase the power of our instruments, that nebulæ yet more remote will be discovered to us. We have endeavoured to show that we have evidence to prove that the stars and planets are, all of them, constituted of matter similar to that existing in the Sun, and that solar matter and terrestrial matter are chemically alike. It is most probable, as we have also said, that the elements may vary in those distinct worlds; and hence the physical differences which we detect. But it is obvious that the nebulæ can no longer be regarded as aggregations of stars, after the order to which our own Sun and the fixed stars belong. "We have," writes Mr. W. Huggins, "in these objects, to do no longer with a special modification only of our own type of suns, but we find ourselves in the presence of objects possessing a distinct and peculiar plan of structure. In place of an incandescent solid or liquid body transmitting light of all refrangibilities through an atmosphere which intercepts by absorption a certain number of them, such as our Sun appears to be, we must probably regard these objects, or at least their photo-surfaces, as enormous masses of luminous gas or vapour." As we advance in our discoveries, it not unfrequently happens that we are led back to the speculations of some older thinker; and the discoveries made by Mr. Huggins rather confirm the views which were entertained by Halley—that the nebulæ are "a gaseous and elementary form of luminous sidereal matter."

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* See Observations on the Stars in the Dumb-bell Nebula, by M. O. Struve, "Phil. Trans.," vol. 151, p. 738.

† Sir John Herschel's opening speech at the meeting of the British Association at Cambridge, 1845.

In the drawing which we have copied (fig. 6), it will appear that a line of faint light has been marked as corresponding with the *hydrogen* line, and that the line of bright light agrees with *nitrogen*. Mr. Huggins, with the caution of a true philosopher, expresses himself so guardedly and so well respecting those lines, that we cannot refrain from quoting his own words:—

> Another consideration which opposes the notion that these nebulæ are clusters of stars, is found in the extreme simplicity of constitution which the three bright lines suggest, as indicating the presence of nitrogen, hydrogen, and a substance unknown. It is perhaps of importance to state that, except nitrogen, no one of thirty of the chemical elements, the spectra of which I have measured, has a strong line very near the bright line of the nebulæ. If, however, this line were due to nitrogen, we ought to see other lines as well; for there are specially two strong double lines in the spectrum of nitrogen, one at least of which, if they existed in the light of the nebulæ, would be easily visible. . . . . The speculation presents itself, whether the

occurrence of this one line only in the nebulæ may not indicate a form of matter more elementary than nitrogen, and which our analysis has not yet enabled us to detect.

Men of imaginative minds have seized, somewhat too hastily, we think, upon the discoveries made by Dr. Miller and Mr. Huggins, and expressed themselves rejoicingly on the confirmation given by them to certain geological hypotheses of world formation. It is prudent to work diligently and wait patiently — advancing with moderation towards the goal. We appear, it is true, to have proved that all the planetary and stellar worlds are made after the type of our own Earth. We learn that they act in relation to light in precisely the same manner as does terrestrial matter, and this mysterious bond unites us, as one family of worlds and parent suns. There is something highly poetical, and at the same time sublimely philosophical in the idea that our terrestrial spheroid, as well as all the other planets, belonged originally to the Sun, as having been formed from detached nebulous rings of the solar atmosphere. By the agency of light and heat, our system is united with other systems glittering in the firmament. The tranquil beams of the distant nebulæ assure us, that, although they may be constituted of elements yet to be discovered, they are in no respect different from terrestrial matter, except in the extreme tenuity in which it probably exists in those remote formations which are only known to us by their phosphorescent gleams. Therefore, to carry our speculations into those boundless fields to which light guides us, and trace, if we can, the condensation of vapours into stars, is a soul-ennobling exercise. At the same time let us remember,—since we are yet in ignorance of the force which binds the particles of matter to form a pebble, and since we know nothing of the power which determines the geometry of a crystal,—that we should, with all humility, pause, before we pronounce a theory upon the formation of a star.

MIGRATIONS OF EUROPEAN BIRDS.

BY A. LEITH ADAMS, M.A., M.B., F.G.S., F.L.S.

THE migrations of animals—especially those of the feathered tribes—constitute one of the most interesting and improving studies that the admirer of nature can pursue. When naturalists were less conversant with the movements of birds of passage, and knew little of their habits and haunts, it used to be a favourite mode of accounting for the regular disappearance of many species by attributing to them what is the case with certain animals, namely, a torpid condition during winter. It was affirmed that certain birds spent the cold months at the bottom of lakes, and gravely asserted by an authority of the last century that "swallows sometimes assemble in numbers, clinging to a reed till it breaks and sinks with them to the bottom; that their immersion is preceded by a song or dirge, which lasts more than a quarter of an hour; that sometimes they lay hold of a straw with their bills, and plunge down in society; and that others form a large mass by clinging together by the feet, and in this manner commit themselves to the deep." Irrespective of the ridiculous absurdity of such assertions, and their want of corroborative evidence, we have the recorded opinions of John Hunter and Professor Owen as to the incompatibility of a bird's organism for such a mode of existence. In all probability, the statement may have in part arisen from the well-known circumstance that many birds of passage tarry in their summer retreats until caught by the cold of winter, when individuals may be found benumbed and senseless; this is a common occurrence, even with the swallows and other birds of northern India, where in the cold months the temperature during night falls often to freezing, whilst at midday it may range as high as 80° Fahr. in the shade. I have also seen the green bee-eater and small warblers so much affected by a temperature of 40° on the banks of the Nile in Nubia as to be scarcely able to fly from twig to twig. The effects of severe winters on many of our indigenous as well as migratory birds have been frequently exemplified by the numbers found dead in sheltered situations, and especially if the cold sets in early, when comparatively few birds of passage escape; for instance, the corncrake has been found in Britain during the winter months: we know of one individual that was picked up on Christmas-day, crouching among furze bushes, almost insensible from cold. The winter homes of European birds of passage comprehend Southern Europe, Lower Egypt, and the countries that lie between the desert and southern shores of the Mediterranean, including the elevated lands of Tunis, Algeria, and Morocco, which, although differing in physical features and, in some respects, in climate, are, strictly speaking, but an extension of Europe, for their flora and fauna are European. It is only when the traveller crosses the Sahara, with its salt lakes and moving clouds of sand, and gains the region of verdure beyond, that he enters on a new zoological and botanical province. It is curious and instructive to observe how well this statement accords with late geological discoveries. From a series of ascertained facts the student of physical science is enabled to speculate on a time when equatorial Africa was divided from the northern portion of the continent by a great sea, of which the Sahara formed the bed; it extended from the Gulf of Cabes to Senegambia in the west, and was many hundred miles in breadth. The Mediterranean sea did not then exist; therefore there was no great obstacle to the southern migrations of animals until they reached the shores of the great central African sea; but as there was no desert in those days, there would be no hot winds to temper the climates northwards, and consequently we should expect to find traces of more rigorous winters in Central and Southern Europe; and such have been clearly proven by certain evidences, which were lucidly explained by Sir Charles Lyell at the last meeting of the British Association. Thus, although we may wonder at the extraordinary intelligence which prompts the bird to cross the Mediterranean, we see at the same time that it is going to no foreign land, where it will not meet friends to cheer it, or food unsuited to its wants. The two great causes which bring about the regular migrations of birds are either change of climate or failure of food—most often both combined. Any ordinary observer must have often remarked that the first effect of a decrease in temperature in autumn is the sudden disappearance of many winged and wingless insects, on which many soft-billed birds of passage depend. At that season swallows, that seemed so full of life and vigour, skimming over fields, threading along the lanes, or twittering from straw-built sheds, are soon seen collecting in flocks, and flitting about with a marked diminution in their activity—now huddling together on the eaves of houses, or assembling in long lines on the telegraph wires; another boreal blast, not yet sufficient to turn the leaf, sends the whole flock southwards, for they soon find that there is no use facing the north from whence the cold puffs are coming, whilst by holding in the direction of the sun, with the balmy southern winds occasionally beckoning them to advance, they soon gain the object of their desires. Thus flocks may be seen pursuing their journey, and picking up a livelihood and more companions as they speed their way over mountain, moor, field, city, or sea to the sunny climes and eternal sunshine of Southern Europe and trans-Mediterranean lands. The majority of migratory birds cross the latter sea during the vernal and autumnal equinoxes; whilst a few, such as certain finches and water birds, make their appearance on the islands and southern shores throughout the winter; the latter, however, are in a great measure dependent on the state of the weather, and their numbers increase or decrease accordingly.

It is evident that such animals as the lapp, lemming, musk ox, or reindeer must push southwards on the approach of winter. Their migrations are by no means unexpected; nor would the mere land journey of birds create amazement when we know the real causes; but to cross the great inland sea anywhere, save at its entrance, must be considered a great feat when performed by tiny warblers, and birds not physically adapted for long flights; for instance, the willow warbler or the land-rail, crossing the broadest parts of the Mediterranean, must traverse at least 600 miles. No doubt the heated winds from the desert exert a great influence in determining the route to be taken by migratory birds, especially in the countries that come directly under their operation; and at no seasons are their presence more apparent than during spring and autumn; for not only then do they blow with their greatest violence, but are also most keenly felt by contrast with the previous hot or cold months. Thus the winds that beckon the bird in autumn to come southward, drive it back again to Europe in spring. Much, however, depends on the constitutional powers of the individual species, which vary greatly in members of the same family: for instance, the little chiff-chaff often makes its appearance in England as early as the middle of March, whilst its congener, the willow warbler, is seldom seen before the end of April; the spotted fly-catcher and night-jar arrive towards the end of May, and depart again early in September. Bird migrations may be said to be either complete or partial: some birds totally abandon Europe during winter, and take up their residence in North Africa; others repair merely to the more genial climates of the south of Europe; whilst many remain, but in diminished numbers, throughout the year, the majority resorting to milder temperatures. For example, the swallow tribe leave Europe entirely; the wagtails have their winter homes among the oases of the desert and on the banks of the Nile, whilst a few tarry in Southern Europe, and with their brethren in spring push northwards. A good many stone-chats spend the winter in Britain, whilst the majority move southwards; not so with their close ally, the whin-chat, which disappears entirely during the cold season, and, with the migratory portion of the last-named species, seeks the more genial climates of North Africa. Thus, in all probability, there are individual stone-chats that have alternately braved the cold of the north and the more cheerful winter of the Sahara; for we cannot suppose that there is a set that invariably stop in the north, and another that constantly leave at the approach of winter. At all events, here is displayed a flexibility of constitution often considered characteristic of man alone. Although the regular birds of passage maintain much exactitude with reference to their arrivals and departures, others seem to err greatly when compelled by weather or other causes to trust to their own intelligence in guiding them from place to place; even many migratory species far exceed the bounds of their usual resorts, and certain individuals, not known to be migratory, have found their way across the whole continent of Europe. A good example of the latter is seen in the late irruption of Pallas's sand-grouse from north-western Asia, so well illustrated by Messrs. Moore and Newton, in the "Ibis." The short-toed lark seldom migrates beyond the northern shores of the Mediterranean, yet finds itself often in Britain, and caught either in gales, or wandering unknowingly northwards; occasional individuals of the Egyptian vulture from Spain, the Griffon vulture and spotted eagle from the mountains of Central Europe, and the spotted cuckoo from North Africa. Moreover, several American species have been recorded, chiefly water birds, which, of course, are better adapted to brave the dangers of the deep. Certain birds—to wit, the redbreast, song-thrush, and blackbird—do not leave the north of Europe, whilst many of their brethren of Italy and the neighbouring countries make regular annual migrations to Africa and the islands. To account for this remarkable anomaly, it will be observed that the robin of the south is far less omnivorous than its northern compeer, and is not nearly so familiar in its habits—like the warblers, it depends almost entirely on insect food; consequently, when that fails, it has no alternative but to push southwards, and participating, like other species, in climatic effects, it would doubtless follow a like route; and much the same with the thrushes, as they depend in a great measure on fruits for their winter subsistence. When the grapes of the south are gathered, having no holly-berries, mountain ash, or haws to draw on for their winter wants, they would naturally disperse; probably many fly northwards as well; for all the thrushes that cross the Mediterranean during winter are but an infinitesimal part of what frequent Italy and the south of Europe in summer. No doubt much depends on the nature of the locality, whether favourable or otherwise; and wherever a complete or only partial failure of food has taken place, so accordingly will the species depart or remain. Moreover, what has just been remarked in connection with the stone-chat, might be applied again to the robins and thrushes of Southern Europe: supposing one of either hatched in Italy, and after several years' migrations to the oasis of the desert, should deviate on one occasion from its accustomed course and fly northwards, and spend the winter in Northern Europe,—with the example of the resident individuals before it, no doubt the robin would soon pick up crumbs at the kitchen door, and the thrushes crowd with their indigenous brethren on the holly-trees, and, becoming climatised, remain in their adopted countries ever afterwards. Although we have no direct proof that such occurrences actually take place, there is nothing in the bird's constitution to preclude such a supposition; and not only that, but we know in the case of Pallas's sand-grouse, and many other accidental visitors, that they have at once adapted themselves to the food afforded by the country, although perfectly new to them. How far such influences, acting on generations and for long periods, do affect the external appearances or internal structure of a species, are points not yet clearly determined; but doubtless, as the geographical distribution and migrations of animals become better known, so will many difficulties of that nature be cleared up. Of the vast hosts of birds that cross the Mediterranean annually, not a few perish on their way, and their bodies are thrown up on the beach; many arrive only to die, as we can testify from our own observations along the shores of Malta, where we have picked up numerous warblers that had been either drowned on their passage or died on the rocks, or had dashed themselves at night against the fortifications and lighthouses.

> "The beacon blaze illures
> The bird of passage, till he madly strikes
> Against it, and beats out his weary life."

The quail on its way to Europe in spring, or Africa in autumn, is often borne back by a strong head wind to the country it had just left; and we have repeatedly noticed that a strong sirocco in September scarcely ever fails in throwing abundance of quail on the south-east coast of Malta, in the same way that a powerful gregale brings in many that had been bent on an opposite direction. We now come to observe that extraordinary intelligence whereby swallows, for instance, are enabled year after year to return to the same nest. Taking into consideration the long absence, the dangers and difficulties incident to the voyage, it seems incredible that any animal not human can be capable, after nearly eight months' sojourn in Central Africa, to return in spring to a farm-yard in the midland counties of England; and still more wondrous, as recorded in "Yarrell's British Birds," that several swifts, undeniably marked, returned not only for three years in succession, but one of the number was caught in the same locality at the expiration of seven years. Here, then, are displayed effects of memory and perception—in fine, a wondrous manifestation of intellect which, under the vague name of instinct (that is, a natural blind impulse acting without the intervention of reason), has been applied, we think, too indiscriminately to such-like mental phenomena among the lower animals. However, a few deep-thinking philosophers of the present day accord reasoning powers to the brute animal as well as man; and surely it can be no insult to the vastly superior intelligence of the latter to have to allow that the brute shares finitely what he enjoys in an infinite degree. None of the eagles of Europe seem to cross the great inland sea, or perform regular migrations. The osprey and Peregrine falcon wander over the south of Europe and North Africa in increased numbers during the winter months. Flocks of honey-buzzards, orange-legged falcons, and lesser kestrels, together with numbers of marsh harriers, kestrels, sparrow-hawks, and in a less proportion the hobby, merlin, and Montagu's and Swainson's harriers, follow the migratory birds to and from Africa—some in hot pursuit of the warblers and quail, which they feed on when they cannot procure more choice food. Thus flocks of hawks may be seen hovering over the fields in spring, and along the southern shores of the Mediterranean, where the birds of passage are assembling before they commence their voyage northwards,—all driven hence by the hot blasts of the desert which, under such local names as harmattan, sirocco, kamsin, simoom, and samiel, soon wither verdure, and compel birds of passage to turn their faces northwards, and fly with all speed to more genial climes. A naval officer informed us that one spring evening, when a hundred miles off the coast of Africa, the rigging of his vessel was covered by small birds, which were seen arriving in scattered flocks from the south; among them were many hawks and a few small-sized owls, possibly the Scop's eared owl, which migrates in great numbers at that season. No sooner had the little birds settled down on the yards than the hawks commenced to prey on them, and were seen actually devouring their captives within a few yards of the officers, who attempted to put a stop to the slaughter by shooting the depredators, but in vain; they continued pursuing the unfortunate small birds from rope to yard-arm and around the vessel, until night put an end to the scene, when friend and foe went to roost, and at break of day all sped their way northwards.

The short-eared and Scop's owls are migratory species; both pass and repass the Mediterranean in great numbers every spring and autumn, not in flocks, but singly; the latter is much in request as an article of food, and killed in several of the islands in large numbers; during its passage through Malta dozens of this handsome little owl may be seen in the poultry market. As beetles, moths, and the larger insects constitute the favourite food of the Scop's owl, and bats enter largely into the fare of its short-eared congener, it may be supposed neither can have much inducement to prolong its stay in Europe after September.

The night-jar, although late in arriving in the north of Europe, crosses the Mediterranean in March; the nocturnal habits of the bird, by restricting its movements to night and twilight, will account for its slow progress; it is also much esteemed by the natives of the south as an article of food. None of the swallow tribe are more exact in their times of arrival and departure than the swifts, which seem to proceed further southwards than any of the others; whether from sudden failure of food or change of climate, or both, it is seldom the black swift tarries on its way; for, not content with the climate of the southern shores of the great inland sea, it pushes on with little delay to Abyssinia, Nubia, and even Timbuctoo. The Alpine swift passes to and from Europe in small numbers; compared with the last-named species, this is a hardy bird; we have seen it and the house marten sporting around Alpine glaciers at the latter end of August, when there was a hoar frost every night, and occasional heavy falls of snow; many Alpine swifts spend the entire year on the Himalayan ranges. The chimney, house, and sand swallows make their first appearance in spring, and leave Europe in the order here given; none seem to pass the winter in any of the islands, and on their arrival in Africa move steadily southwards to more genial regions. The rock swallow and rufous swallow make regular migrations from Asia Minor to south-eastern Europe, few venturing westward of Greece. Owing to the strong N.E. winds that prevail during the cold months, and sweep along the Mediterranean basin with great violence, many birds are blown from one coast to another, and turn up in districts in every way uncongenial to their habits and wants: thus are recorded by C. A. Wright, Esq., in his admirable catalogue of "Birds observed in Malta," the appearance of the diminutive golden and fire-crested wrens among the woodless tracts of these bare islands; supposing them to have come from the nearest point of Sicily, they must have flown at least fifty miles! Along the shores of the Mediterranean the approach of spring is heralded by flocks of gaudy bee-eaters which may be seen advancing northwards in scattered hosts, emitting their characteristic call-note. We have watched them approaching Malta during the calm and delightful weather at that season, when a few attracted by the verdure would break off from the rest and descend, whilst the majority continued steering their course in a northerly direction. Luckless is the bird wanderer that makes a temporary resting-place of Malta at any time, especially on Sunday, for no sooner is an individual recognized than a dozen guns are put in requisition, and soon the fair forms of the bee-eater, oriole, &c., are seen stretched in rows on the benches of the poulterer. The weird-like form of the hoopoe may constantly be seen drifting before a south wind in spring, or hastening southwards in August, seldom in flocks, but so numerous that on one occasion, on a projecting rock in the island of Gozo, we saw in the course of half an hour no less than ten hoopoes arrive, one after another. None of the woodpeckers, neither the creeper, nuthatch, nor the wren seem to migrate. The warblers, no doubt, constitute by far the greatest majority of the birds of passage, and may be said to be most punctual in their time of arrival and departure. As with other groups, many entirely abandon their summer or winter residences at the migratory seasons, whilst others leave a few stragglers behind. The sedge, willow, garden, the chiffchaff, whitethroat, Sardinian, Dartford, sub-alpine, Vieillot's warblers, and the blackcap annually cross and recross the Mediterranean with undeviating regularity, some in enormous numbers, especially the garden warbler and whitethroat, which being then plump and in good condition are in great request, and constitute the Italian's much relished *beccafico*. The nightingale appears in considerable numbers and shares the same fate with the last-named species. The two redstarts, wheatear, whin, and stone-chats, with the redbreast, come and go to Africa regularly, leaving a few stragglers on the islands during winter, which, however, unite with their brethren from North Africa in spring, when all proceed to Europe. The blue-throated warbler repairs to Egypt in winter, from the south-eastern countries of Europe and western Asia. A small migration takes place of the russet and eared wheat-ears annually to southern Europe in summer, and back again to the African deserts in autumn. As the song thrush and blackbird are plentiful throughout the year along the Atlas range, it is probable few of them return in spring, and whatever do cross in autumn and winter remain with the residents. The golden oriole passes through Malta regularly on its way northwards, and in small flocks returns to Africa immediately after the harvest and fruit are collected in autumn. The ring ousel is also migratory, and although a few missel thrushes and redwings appear on the islands and southern shores during the cold season neither can strictly speaking be called birds of passage, as their numbers seem entirely dependent on the state of the weather in Europe and local gales. The tree, meadow, red-throated, and tawny pipits cross and recross regularly, and often in large flocks. The meadow-pipit is another illustration of a bird which remains all the year in northern Europe, but is migratory in the southern parts. As soon as the hot weather has fairly set in in Africa, flocks of the short-toed lark proceed to southern Europe and distribute themselves over wastes; like other desert-living birds, it is very sensible of cold, and accordingly quits Europe before the regular migratory season. The sky, crested, and Calandra larks go southwards late in October and the following month; the two last-named are extremely abundant in north Africa during winter. The woodlark repairs to southern Europe during the winter, but a few also regularly push further southwards, and cross again in spring. The pied wagtail and its northern variety, called after the late Mr. Yarrell, repair to southern Europe on the approach of winter, and many also cross the great inland sea and proceed a long way into Africa; we found the former very common up the Nile to the second cataract. The grey wagtail, although nowhere so common, follows the same course and pushes northwards at the same time with its congener in spring. The yellow wagtails of Europe have been so frequently confounded and misnamed, that until the student has carefully examined specimens of each he will be almost sure to become confused. There is, first, the yellow wagtail of the British Islands, called also Ray's wagtail, that migrates to the Continent in winter, but we opine not to southern Europe; this bird has been mistaken for the yellow wagtail of the Continent, first described by Linnæus. Enormous flocks of the last-named bird cross regularly to and from Africa annually: probably not a straggler remains in either country after the migratory seasons are over. We have repeatedly noticed varieties of this wagtail, with grey and black-coloured heads, which many naturalists consider as specific differences, whilst others appear to class them under the head of a race or variety of the Motacilla flava of Linnæus. We are enabled so far to strengthen the latter opinion, by the fact that in a large series of skins collected from flocks of yellow wagtails during their migrations across the Mediterranean, we could make out a gradual transition from the one state of plumage to the other, and we frequently found the grey, black, and olive-headed (or yellow wagtail proper) all in one flock and constantly associating together, and with the same call-note; the only difference was the call-note in autumn in some was noticed to be harsher; these, however, we ascertained to be birds of the year. The rook is migratory in south-eastern Europe, and repairs to the delta of the Nile in large flocks; sometimes it is driven by stress of weather to the islands of the mid and western Mediterranean. The northern portion of Africa is a favourite resort for the starling in winter, when flocks may be constantly seen all over the south of Europe; they quit, however, in spring and go northwards. The jay has been recorded as migratory, and said to frequent North Africa, Malta, and Egypt. We cannot, however, find any authentic confirmation of this statement. All the European flycatchers cross the Mediterranean very punctually. The spotted bird is by far the most numerous, next the pied, and in a much less proportion, the white-necked flycatcher. The first has a very extensive geographical range, embracing the whole continent of Africa and Europe, and breeds in great numbers even in North Britain, where we have seen large flocks in autumn pursuing their retrograde course southwards. The woodchat shrike seems to be the only representative of the family that regularly leaves Europe in winter; its red-backed congener has been said to migrate to North Africa. The finches are always late in migrating in autumn, and leave North Africa long before the other birds of passage; at all times much depends on the severity of the weather, their numbers increasing or diminishing accordingly. No doubt, like the thrushes and other species indigenous to temperate climes, many individuals extend their range during the winter months, not so much from failure of food, as the cold weather allows them to wander over regions inimical to their constitutions and wants in summer; from this cause and the state of the climate in north and mid-Europe, together with the transporting power of gales, may be attributed the pretty regular appearance of flocks of the following finches on the islands and southern shores of the great inland ocean. The linnet is plentiful in Egypt and North Africa in winter; small flocks of the chaffinch, greenfinch, goldfinch, common buntings, sirinfinch, grosbeak, and ortolan may be seen among the tamarisk and olive groves of North Africa at the same season, whilst a few solitary individuals of the crossbill, scarlet grosbeak, reed and meadow buntings, cirl and bramble finches, tree and rock sparrows, find their way in winter to the islands and southern shores of the Mediterranean. The cuckoo and wryneck are among the foremost birds of passage that cross to and from Africa, and both seem to have much the same geographical distribution. We have heard the cuckoo's welcome note among the carol trees of Malta in March; in the north of Europe in May; among the stunted birch trees on the confines of perpetual snow on the Himalayan mountains in July; and often recognized its handsome form among the orange groves on the torrid plains of India as late as November.

Many wood and stock pigeons migrate to Africa in winter; their head-quarters, however, would seem to be located in the south of Europe; not so with the turtle dove, of which flocks of thousands may be seen steering their course southwards in autumn and *vice versâ* in spring; very few, if any, remaining in Europe or in Africa at the termination of their migrations. At these seasons they are caught in great numbers, by means of clapnets and decoy birds. The quail invariably flies within a few feet of the sea when crossing.

As soon as the cold weather has fairly set in along the shores of the Mediterranean, a partial migration of the following plovers takes place. The Norfolk plover disperses in winter over the islands, and penetrates far south to central Africa. During November flights of golden plovers arrive on the northern exposures of the Maltese islands; also a few of the grey and a good many of the lapwing plovers, all of which go to Africa. The dotterel, with its two-ringed allies, and the Kentish plover, pursue much the same course, perhaps if anything more of all these pass in autumn than recross in spring, for the reason that several of the species are resident in Africa, and extensively distributed over the entire Continent. The common heron and crane repair southwards to the African lakes and rivers, and may be seen during the winter months flying at great heights; neither is attracted by the mere appearance of land, whilst the purple heron Egret squacco, night heron, little bittern, glossy ibis, whimbrel, common and slender-billed curlews fly at lower levels, and tarry on the islands on their way.

The frosts of October and the following months drive across the inland sea myriads of greenshanks, wood, the common and little sandpipers, stilts, water-rails, the common, spotted Baillons, and little crakes, and the coot. In smaller numbers come black-tailed godwits, common and jack-snipes, common and spotted redshanks, marsh and green sandpipers, with ruffs, the great snipe, knot, curlew sandpiper, dunlin turnstone. Now and then the woodcock wanders across, but as a rule its migration is mostly confined to the south of Europe. The Adriatic gull extends its range over the western Mediterranean in winter. Many northern gulls and terns, to wit, the herring, lesser, and black-backed gulls, Sandwich, common, the little, the black, the white winged, and the whiskered terns spread themselves over the sea, and wander up the Nile and to the lakes of North Africa. Of the duck tribe nearly all go north in spring. Among others, we have noticed the bean goose, shoveller shelldrake, mallard, pintail, gadwall, widgeon, teal, gargany, and castaneous ducks; the red-breasted merganser, and the cormorant; the crested, horned, eared, and little grebes.

ON THE DIFFICULTIES IN IDENTIFYING MANY OF THE LOWER KINDS OF ALGÆ.

BY J. BRAXTON HICKS, M.D., F.R.S., F.L.S., &c.

SUPPOSING any one were to endeavour to persuade the botanical readers of this Journal, that from looking at a single green cell of any leaf under the microscope he could tell the plant to which it belonged, and that without the necessity of inquiring into the modifications it might undergo in different positions of the plant, and at various periods of its existence; there are few at all versed in microscopical knowledge who would not at once recognize the impossibility of the case, and the want of depth in the declaration.

And yet for many years this to a great degree has been the statement made with regard to the simple forms of vegetable life, consisting of a single cell; I mean to those forms which, from having been supposed the lowest forms of vegetable life, are called "Protophytes," Confervoids, or lower Algæ.

They are composed, for the most part, of only one cell, of varying forms and colour; and are capable of growing; of dividing; or *segmenting* into many parts, and that in many directions, both round a common centre, through their long axis, or through their short one. The contents of the cell are also capable of resolving themselves by subdivision into numerous parts, not in any specific direction as above, by which there is formed a group of small cells within the parent cell-wall.

Sometimes the parts separate from each other at once, sometimes they remain in contact for a variable period, whereby masses of cells are formed, more or less connected, but without any definite arrangement or mutual dependence; so that any portion being separated is capable of continuing its growth without suffering injury. The size of the individual cells varies considerably. From my own observations it seems impossible to limit the extent to which they may decrease by repeated segmentation. It may be carried to fine points, even seen under high microscopic powers, in which condition they have been called "Granules" or "Molecules." These small fragments may, however, grow till they attain the size of their origin.

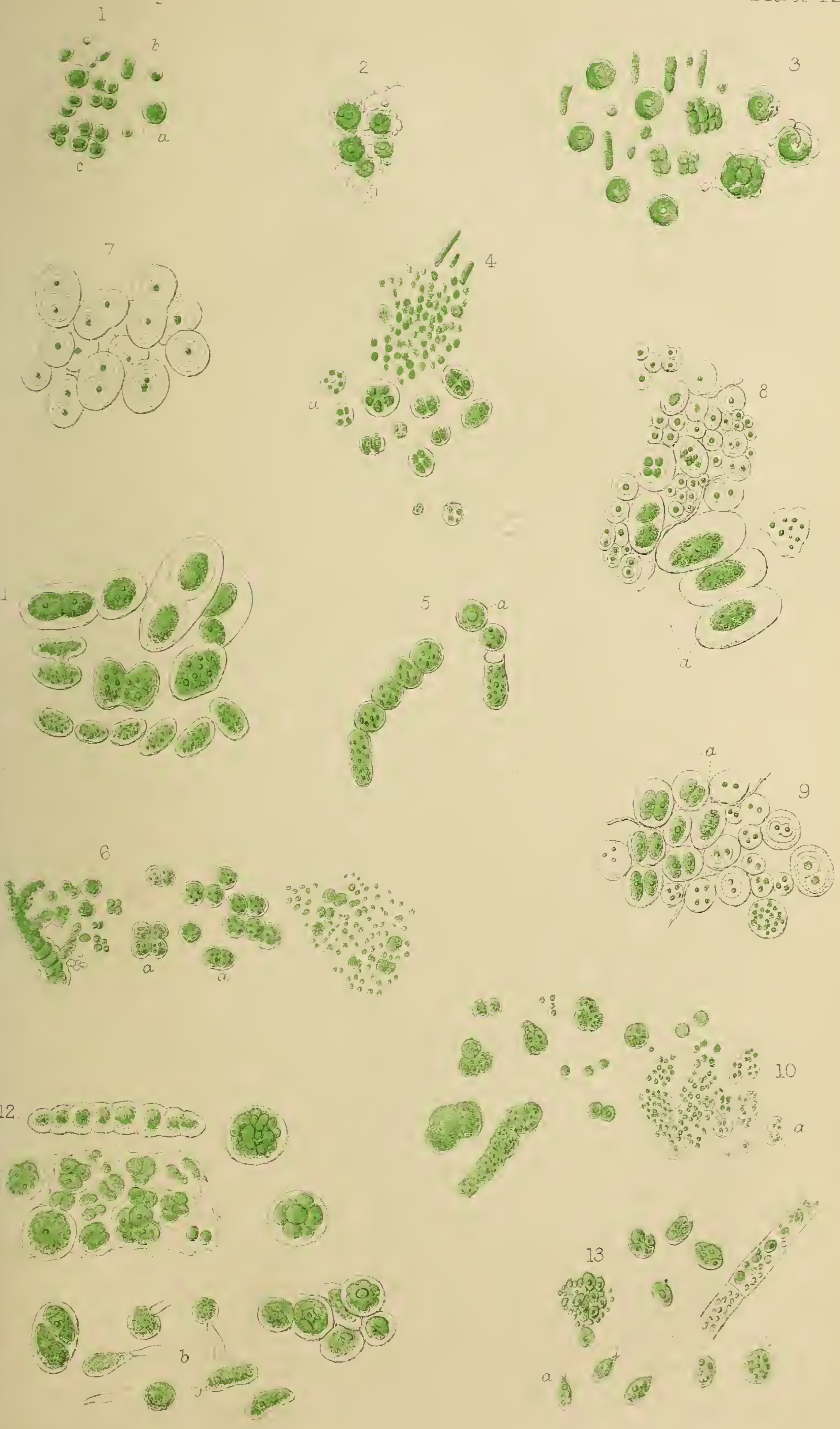
Indeed, some have the power of increasing beyond this, and then they have had the prefix of "Macro" (from μακρος, long) given them; as "Macrogonidia." Thus it will be seen that the size of a cell alone cannot be made use of to distinguish species.

These cells again may change colour, according to the season of the year, the moisture, temperature, &c. In winter they change more or less to red or orange; as the functions of the cell become active with returning warmth, the colour changes again to green; frequently at this time both colours may be observed in the same cell. A well-known example may be cited in the "red snow" vegetable cell found by arctic and mountain travellers on the snow, having a form similar to that shown at fig. 12, Plate XIV., of which, or of a kindred growth, it is the winter state. This feature, therefore, cannot be made use of as a specific character.

Again their external casing, or cell-wall, may soften down and disappear, leaving the contents of the cell soft and without protection; under which state it may possess the curious property of altering its form, and moving about slowly, giving it the appearance of an "Amœba," which is one of the simplest forms of animal life, or, as these are called, of the "Protozoa." This power of motion, &c., is not confined to the algæ, but has been observed by Hofmeister, Beale, myself, and others, in the higher orders of plants. This is not the place to discuss the nature and cause of this motion. It is sufficient for our present purpose to show the variety of conditions which are natural to vegetable cells at different stages of their existence. However, the cell-wall does not always set free the contents by dissolving, but a portion of it splits off like a little lid, or into two equal halves.

This slight outline will help to show the many circumstances which may combine to render the appearances of the progeny of a given cell so dissimilar, that at first sight each variety might be considered as belonging to a totally different group; indeed, the older algologists actually did so, taking at one time size; at another time the mode of division; at a third colour, or form, as a specific or even generic sign. Frequently their description was taken from portions of masses which had been dried upon paper, and transmitted by post. Thus descriptions became confused, ill-defined, and the positions of the species and genera constantly changed by each successive writer. Only a few algologists ventured to study the life-history of a small number—for instance, Cohn's paper on the Protococcus pluvialis and Volvox. These efforts were attended with excellent results, and no doubt they have stimulated others to follow the same plan, and have given us a history (or a portion at least) of one cell, which included in its phases many forms

Plate XIV.



B. Hicks del, T. West, sc

The Lower Algæ.

W. West, imp

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NATURAL HISTORY

till then supposed distinct. Histories carefully followed out, like that of the Protococcus by Cohn, open up a page in the life-history of vegetable growth infinitely more expansive in its physiological bearing, infinitely more expanding to the mind; much more amazing in regard to the variations of nature than had been declared by the former observers, who had not often looked beyond the state of the specimen before them, and who had in that specimen excluded all other forms, except those about the same size, of the same colour, and deriving evidently from the same stock. Beyond this their inquiries did not often extend. They were contented, if they found a new form, to place it in a group already established, or to make a new genus for it, without inquiring further; and then, once placed, its destination was fixed for a long period.

Having thus had his attention directed to the basis upon which the groups of lower algæ, especially the Palmellaceæ, were founded, the reader will probably see that if it were subsequently discovered that, as far as could be distinguished by the microscope, identical forms were produced by the higher plants, a difficulty would immediately present itself during an observation whether the so-called Palmellaceous plant were indeed a separate independent organism, never altering its state, or derived from a higher plant.

It will perhaps not be surprising, that when I noticed that growths, indistinguishable from the lower algæ, were to be produced from certain parts of the lichens, mosses, and certain other plants hitherto grouped as algæ, but really quite distinct,* I should have ventured to question the possibility of identifying the so-called Palmellæ, and kindred groups. While I did not deny the possibility of the separate existence of these groups, I endeavoured to show how little reliance could be placed upon the hitherto accepted observations, and to urge upon observers to devote their energies to the study of their whole history, rather than limit nature in the way already done.

But the task is a severe one, requiring much patience, accuracy of observation, careful delineation, by no means attractive to minds who wish to show early the results of their labours; nor to those who delight more in definiteness and conciseness, than in following truth with hesitating steps; who delight in subdivision rather than in synthesis. But by what other method can we attain the end in view? Indeed, from the facts shown of late years, it is clear that till this is done we must consider many of the simpler forms, at least, as only provisionally placed in the present scale of vegetable life.

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* "Jour. Microscop. Sc.," 1860 (July and Oct.), 1861 (Jan.). Also in same Journal, on "Lyngbya Muralis," 1861, and on "Statospores of Volvox." Trans. Linn. Soc., 1862, on "Gonidia and Confervoid Filaments of Mosses, and on relation of their Gonidia to those of Lichens and certain freshwater Algæ."

Having premised thus much, let me point out some instances of the similarity between the so-called Palmellaceæ and the cells produced by lichens, mosses, &c.

If we place under the microscope a small portion of the green grains found on the bark of every tree, paling, or wall in winter, it will be seen to resemble the cells in fig. 1, Plate XIV. To it has been given the name "chlorococcus," or *green berry.* This growth is very easily obtained and observed. It consists in the full-grown state of a single cell (fig. 1, *a*), with green contents, and a nucleus in the centre. The contents are not entirely uniform, but somewhat granular and slightly radiating from the central nucleus. But all are not single cells. Some are divided by a line in two portions, and subdivided into two cells, which form is called binary segmentation (fig. 1, *b*). Some are divided crosswise by two partitions into four parts, the plan being called quaternary segmentation (fig. 1, *c*). These processes form a common mode of multiplication. Division may proceed with such vigour that it extends to the fourth or fifth generation before it is complete in the first. Sometimes, as before stated, it passes on to the reduction of the cell to exceedingly minute portions, which, endued with the power of growth, gradually increase in size without dividing, and at last resemble the parent cell. Again, division may take place in a radiating manner, so that five or six wedge-shaped portions may be produced, which will, when separated, become round cells. Some of the smaller divisions, instead of dividing as usual, elongate first in one direction, and then divide into two parts across the middle without separation; by this process, continued growth and division thus proceeding simultaneously, a long jointed filament is produced, which by a retroversion of the process may ultimately reproduce the round cell.

The reader has been detained over this somewhat tedious description in order to make him acquainted with the ordinary process of division of single cells, whatever their origin.

Let us now see how this "chlorococcus" may be imitated. If any one will allow snow to fall thickly on a clean sheet of glass, and pour it, when melted, into a deep glass, he will observe some dark matter settling to the bottom. When this is placed under the microscope, amongst others, forms similar to those of chlorococcus will be found. Attached to some of them he will observe some transparent colourless fibres, in some cases holding some of the cells together. To one accustomed to examine lichens, it will be at once apparent that these are really portions of lichens, either of its true substance, or of the mealy portions called "sori" found on the surface of many. These meal-like grains are situated on the exterior of many old lichens, generally of the colour of the parent frond; under the microscope they are opaque, but when compressed under the glass they are seen to be composed of from one to many green cells; around and amongst which there are to be noticedcolourless tortuous fibres (figs. 2, 3). These are the fibres which form the major part of lichens, so that these sori contain the elements of these plants, though not as yet assuming the shape of the parent.

Now the green cells, before mentioned, to be obtained from snow, in the interior of lichens, and in their sori, are, so far as the eye can distinguish, in form, mode of growth, &c., identically the same.

But further, they are not distinguishable from the mature round cell of the Chlorococcus, the green plant already noticed as occurring so extensively on barks of trees, &c. Besides, if the green cells of most of the lichens, as Parmelia, Lecanora, &c., are kept moist, or in water, and watched under the microscope, they will be seen dividing (fig. 3) exactly as Chlorococcus, shown in fig. 1. An easy mode of observing these changes is to place a small portion of the object on a glass slide with a drop or two of water, covering it over with the ordinary thin glass. Over this place a watch-glass, by which means evaporation is much retarded; a little water should be supplied as often as required. The watch-glass being removed, the slide can be placed on the stage of the microscope.

Thus, then, we find that the green cells, or "gonidia" as they are called, of the lichens, are imitators of the Chlorococcus.

But there are others. On the ground at the foot of palings, trees, and walls, in the early part of the year, may be seen wavy strips of light-green growth of varying width, frequently narrower at one end than at the other. This growth has been known by the term "Prasiola." It was the object of one of my papers to point out that this Prasiola had been during different stages of its increase placed in three distinct genera wide apart. For continuous observation easily discovers that it springs first from round green cells (fig. 1 *a*). These grow into filaments in the mode already shown, having one row of cells. These again divide laterally, so as to make a filament of two rows, which, repeating the process, make a tapering wavy band. However, the point with which we are concerned is this; that the filaments spring from cells which entirely resemble the Chlorococcus first mentioned, both in colour, size, form, and mode of division. Besides which, the filaments become at certain times disjointed at their extremities, the portions assuming the globular form. Indeed, this is the case with any portion of it at any stage; and although at certain times these do not always resemble the cells of chlorococcus, yet in the main the resemblance is very complete.

Again, the Mosses produce forms in many of their stages similar to those already pointed out.

The Mosses are provided with filaments similar to the Confervæ (hence called confervoid filaments), which may indeed spring from almost any part, but generally just above the radicles at base of stem. These spread from the parent to a great distance almost indefinitely, and branching, frequently produce an appearance of a conferva, so much so that they have been classified under the algæ, till Kützing separated them. The branches, during active growth, frequently crowd each other so much that the ends are pressed upwards, and a dark green velvety mass covers the ground on which they rest. The terminal cells of these are constantly thrown off (fig. 5*a*), and are capable of subdivision. Although they are rather different from Chlorococcus and more like a form to be mentioned hereafter, in the first generation, they shortly assume the characters of that growth. When the filaments are produced in drier situations, as on branches of trees, they are more tapering, and the end cells are thrown off, as in fig. 6, and begin to divide (*a, a*), and ultimately to assume the exact appearance of the before-named Chlorococcus. The component cells of any part of a moss, indeed, may, under certain conditions, be thrown off, and then it will divide in the same manner.

These remarks will thus show that although it may be possible that such a distinct growth as Chlorococcus may exist, yet that inasmuch as we already know that a form like it may have at least three distinct origins, and perhaps many more, it may naturally be asked, how is it possible for any one to assert, that with so extensive a distribution as the mosses, lichens, and Prasiola, the specimen we are observing is in truth a distinct growth?

But Chlorococcus is only but one of the so-called Palmellaceæ. There are, of course, many other forms, some of which are imitated by the further changes which may be observed to take place in the cells of lichens and mosses. The Cup-moss, "*Cladonia pyxidata,*" is a good example to observe.

At fig. 7 is shown what is called "Gleocapsa," where the green contents of the cell are surrounded by a thick colourless transparent layer of mucus-like matter, instead of the ordinary thin hard cell-wall. The one figured has many layers; some have only one. This feature has been used to distinguish the genus, and to divide it into different species. If this Gleocapsa be compared with those at fig. 8, it will appear similar, and yet these are the results of subdivision of the cells of the Cup-moss in very wet places or under water. They can be produced by placing the mealy grains on the Cup-moss in water or on a slide in the manner above recommended.

The little reliance which can be placed on the number of transparent layers as a specific distinction is very apparent, when in divisions from the same cell they vary so much.

Again, in looking at fig. 10 *a*, which is derived from moss, it will be seen that the same condition occurs in the cells of moss placed in water, or in very damp places.

Thus Gleocapsa can be produced from at least Lichens and Mosses.

There is another genus of the same group, called "Palmoglea," which is oval in form, and larger than the above Palmellaceæ, which may be, in some of its stages at least, imitated, so that the one cannot be distinguished from the other. It is figured at fig. 11. A form like it can be produced from Cladonia by the division and growth of its cells (figs. 8*a*, 9*a*). The confervoid filaments of mosses also throw off cells which are apparently the same. Whether at any time these undergo the change noticed in Palmoglea, called "conjugation," where the cell-wall of two adjacent cells bursts, and their contents unite to form one mass, further observations are required. Suffice it for the present paper to show that at certain stages these are all so similar, that they might, without following their history deeper, appear the same plant.

Further, at fig. 12*a* is shown what is called Protococcus viridis. It segments as Chlorococcus, from which at times it is impossible to distinguish it. However, some of the cells are more oval than the others, and have two delicate hairs or cilia from one end. These cells move about freely in water by the movements of these cilia, and are called "zoospores" (fig. 12*b*). They were at one time placed in the animal kingdom. But we have every reason to believe that this form of cell, very common in the Confervæ, is also produced by the confervoid filaments of the mosses (fig. 13*a*).

Now it may here be mentioned that the green cells given off by mosses, lichens, Lyngbya, Volvox, are all called "gonidia;" in essence they are somewhat analogous to the "bud" of the upper plants.

It will easily be perceived, by any one who has observed the amazing number of these growths thrown off from the above-named plants, to what an extent they are capable of being propagated, though it must be here remarked that these gonidia and their subdivisions under favouring circumstances do reproduce their originals.

And this brings me to the last fact to which I wish to draw attention. *These gonidia can continue for an indefinite period in the same mode of growth to which they have passed, while the external conditions remain the same.*

Now this is an important fact, because it strikes at the force of the argument which considers the apparent fixity of the Palmellaceæ as an evidence of their separate entity. It shows the necessity for these studies of enlarging the field of our researches; of expanding our comprehension of the variability of nature; and of continuous patient careful observations.

Any one looking for the first time at the plate to Cohn's paper on Protococcus pluvialis, translated in the Ray Society's work, 1853, will be astonished at the very diverse forms which he has traced from the simple cell, which was considered till that time to form its whole existence. What a field then, in all probability, remains for future observers, endowed with an equal amount of industry. The reason so many disputes concerning the animal or vegetable nature of Volvox and many other organisms have arisen, has been from the want of continuing the observations on their mode of growth for a longer time; as well as from our want of collateral knowledge of the development of similar plants.

Let us then extend our researches in this direction, let us determine our species and genera rather by their mode of growth than by their particular form, seen only for a short time or under similar conditions; a great opportunity is here for many investigators, one which will not be exhausted for many years. The whole of the Confervoids require to be thoroughly gone through in their modes of growth under varying conditions. This is a task not attractive to some; but to the patient intelligent observer it will yield far more satisfaction, a deeper insight into nature's ways, and a greater expansion of the mind, than can ever be obtained by the mere seeking for species.

DESCRIPTION OF PLATE XIV.

Fig. 1. Chlorococcus in different stages of division.—2. Sori of Lichen opened, showing the green cells or *gonidia.*—3. Cells of same in a state of division.—4. Simple cells of Prasiola, dividing in various manners.—5. Confervoid filaments of Mosses, throwing off cells.—6. Ditto, ditto, which are dividing in various ways.—7. Gleocapsa.—8. Green cells of Cup-moss, producing cells like Gleocapsa and Palmoglea.—9. Ditto, ditto.—10. Green cells of Confervoid filaments of Mosses, producing forms like Gleocapsa.—11. Palmoglea.—12. Protococcus iridis, producing Zoospores (*b*).—13. Cells of Moss, producing Zoospores (*a*).

N.B.—Figs. 7, 11, and 12, are drawn on rather too large a scale; they should be same size as those with which they are compared.

ON THE OLDEST KNOWN FOSSIL, *EOZOON CANADENSE* OF THE LAURENTIAN ROCKS OF CANADA; ITS PLACE, STRUCTURE, AND SIGNIFICANCE.

BY PROFESSOR T. RUPERT JONES, F.G.S.

WE all know that it was a long time before even naturalists fully understood that fossil shells "were not created by God in the bowels of the earth, but bred at sea" (J. Woodward); and though hazel-nuts in peat, and bones in gravel, spoke for themselves as imbedded relics of plants and animals, yet their lessons were long neglected; the big bones went for fabulous giants; and shells, fish-teeth, tree-stumps, and so forth belonged only to curiosity-mongers and "the deluge." In time, however, by the natural links of cause and effect, layers of fossil shells were rightly connected with old sea-beds or lake-bottoms, and petrified oysters and cockles were no longer regarded as having been washed by a cataclysm into supposed crevices and caverns, or as having been mixed up in a fancied diluvial *magma*. But long after many of the layers of shelly rock, coral-limestones, or other strata with well preserved fossils, had been duly recognized as successive beds of shifting seas, that had come and gone over this or that part of the earth's surface, the rock-masses still lower down,—grauwacke and slates, schists, gneiss, and granite, remained to be understood.

By Sedgwick, Murchison, and others the indefinite "grauwacke" was stript of its obscurity; its folds and ridges, often complicated and distorted, broken and shifted, were traced out and got to order; its fossils were brought to light; and "Devonian," "Silurian," and "Cambrian" came out like the reading of half-burnt papyri in Herculaneum. As for the "primary schistus,"—the crystalline crust of a cooling globe, with seas of boiling water, rearranging the dust of a primæval granite in contorted beds of mica, quartz, and felspar, and in thick layers of felspathic mud,—this was one form in which the mineralogical nature and apparent structure of the schistose rocks were made to hold together. The intrusion of molten rock, dragging out some of its plastic mass into riband-like gneiss, and crystallizing as granite in axial mountain-ranges,—this was a modification; the alteration of old sea-beds of sand and clay and shell-rock into quartzites, slates, and marble by heat from below, drawn upwards by the thickening masses of heat-conducting sediments above—was another; and the side-thrust of intruding granites, and lateral pressure from contractions of the earth's crust,—both of them producing chemical changes by the heat evolved, and mechanical changes by shifting the particles of the rocky mass itself, modified our views still more. And now, whether the granites (for they are many) owe their present form and structure to heat mechanically produced by lateral thrust, or to heat from beneath, they no longer stand as out-cropping eminences of a primæval crust, but as witnesses either of extreme changes in the contorted sheets of sediments where resistance to pressure was greatest, or of the force of inner heat, driving molten rock into the earth's crust, perhaps as the deep-seated foci of old volcanoes, long since planed down almost to the base of their clogged up hearth. The former notion is sufficient for most cases where the granitic boss or axis is the "metamorphic" representative at once of all the elements of sand, silt, and lime-rock: whilst gneiss and mica-schist and marble-bands represent these matters more distinctly, together with graphite for coal-seams, and many a combination of two or more of the commonest mineral substances (lime, iron, alumina, silica, &c.) to represent the whereabouts of organic remains.

Even vein-granite, syenite, porpyhry, and greenstone are included by some among metamorphic rocks, not having necessarily been produced by dry heat, whether volcanic or plutonic, but being possibly the results of "hydro-thermal" agency (water and heat combined), where water confined in the greatly heated rocks, by pressure of overlying and laterally crumpled strata, has been a strong chemical agent, aided by the alkaline salts it contained.

Nowhere have researches been more systematically carried on for threading the almost inextricable maze of "metamorphic" rocks than in the Laboratory of the Geological Survey of Canada; and great results have come from thence. Dr. Sterry Hunt, one of the Canadian Geologists, appreciating, using, and acknowledging the labours of his fellow-geologists and mineralogists of America and Europe, has minutely examined and boldly handled these old altered rocks; and not only has he done much in showing their various relationships to each other and to unaltered sediments, but he has offered a comprehensive theory of the successive formation of rock-masses, alternately sedimentary and metamorphic, and varying in the proportion of contained alkalis, as might be expected from the constantly recurring loss of some soluble matter in the waters wearing down the successively changed and upraised masses, and depositing their débris in consecutive sea-beds. The Canadian Surveyors also, if not so early in finding fossils in "metamorphic" rocks as Prof. W. B. Rogers, who got Trilobites in the much-cleaved schists of Braintree (near Boston, U.S.), have found abundant evidences of primæval life in still older rocks than those of Massachusetts.

Sir W. E. Logan and his associates in the Geological Commission of Canada have had to occupy themselves with—1st. The superficial shell-marls and peat-beds; glacial clays and sands with fossil shells, bones, &c.; and glacial and gold-bearing drifts: 2nd. All the intermediate Tertiary, Secondary, and Upper Primary formations, so well known elsewhere, being absent,—the Lower Carboniferous conglomerates and sandstones of Bonaventure Island (2,700 ft. thick): 3rd. The Devonian sandstones, shales, and limestones, with their bituminous beds and petroleum-springs, 6,000 ft. thick in the neighbouring States: 4th. The Upper Silurian Beds, about 600 ft. thick, containing gypsum and curious "crystallites," or natural stony casts and moulds of crystals of sea-salt and sulphates of magnesia and soda, and yielding brine-springs in New York: 5th. The Middle Silurian (about 500 ft.): 6th. The Lower Silurian, in its many sub-divisions and complicated arrangement, about 7,000 ft.: 6th. Coming up from beneath these, in places, are the quartzites, chlorite-schists, clay-slates, marbles, and bedded greenstone (altogether 18,000 ft. thick), which have been distinguished by Sir W. Logan as the Huronian formation: 7th. Still lower in the geological series, great and wide-spread rocks of Labrador-felspar and hypersthene, with gneiss and crystalline limestone, altogether 10,000 ft. thick, have also been recognized by the Canadian geologists as constituting a stratified, though much-altered, formation (Upper Laurentian), resting "unconformably" on the worn edges of a still lower and older group of gneiss, quartzites, conglomerate, and marble,

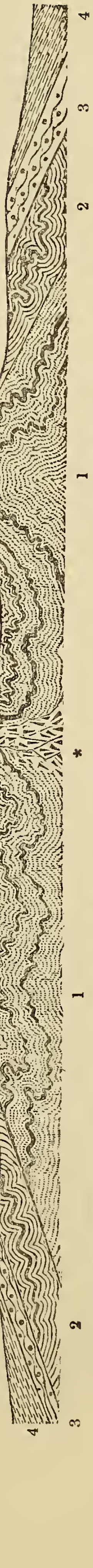

Fig. 1.—Diagram showing the relations of the Laurentian and overlying Rock-systems in Canada.—4. Devonian and Silurian; 3. Huronian; 2. Upper Laurentian; 1. Lower Laurentian; A B C, the three zones of Lower Laurentian Limestones (C, the Grenville zone). * Granite.

20,000 ft. thick at least, crumpled and crystalline, converted here and there into granite, and traversed by intrusive syenites and greenstones.

This is the Lower Laurentian, complete, as a geological formation, with sands, clays, and lime-rocks, though so greatly changed, and even at first regarded as not destitute of evidence that organic beings had been present in the waters that received those prodigious accumulations from the wear and tear of still older lands, when destruction and renovation probably alternated with far greater rapidity than at present. Graphite also in this formation indicates the former presence of carbonaceous forms, animal or vegetable, or both; phosphate of lime, too, fluor, and oxides and sulphides of iron, have reference probably to former animal organisms and their decompositions; and the limestone was possibly accumulated there, as since, by shells, encrinites, corals, bryozoa, and corallines, secreting the carbonate from the sea.

Some obscure coral-like bodies were, indeed, found in these old rocks; but they showed no definite structure; and yet it was rightly thought by Sir W. Logan that they must be of organic origin, or how else should different mineral matters, in the several specimens, occupy the same relative positions in these somewhat concentrically laminated bodies: the *form* must have been due to some organism, which had been replaced, in alternate lines, by pyroxene and carbonate of lime in one case (from the Grand Calumet, on the Ottawa) loganite and dolomite in another (from Burgess). As in many other instances, what appeared at first sight irregular and exceptional, was found to be a normal result of intelligible conditions, when more light was thrown on it by well-directed research, consequent on Sir W. Logan recognizing in some green Laurentian marbles, from Grenville, an arrangement of material similar to that in the dubious fossils.

> In this case (writes Sir William),* the forms were composed of serpentine and calc-spar; and slices of them having been prepared for the microscope, the minute structure was observed in the first one submitted to inspection. At the request of Mr. Billings (the palæontologist of our Survey), the specimens were confided for examination and description to Dr. J. W. Dawson, of Montreal, our most practised observer with the microscope; and the conclusions at which he has arrived are appended to this communication (Op. cit., p. 51). He finds that the serpentine, which was supposed to replace the organic form, really fills the interspaces of the calcareous fossil. This exhibits in some parts a well-preserved organic structure, which Dr. Dawson describes as that of a Foraminifer [under the name of *Eozoon Canadense*] growing in large sessile patches, after the manner of *Polytrema* and *Carpenteria*, but of much larger dimensions; and presenting minute points which

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* Journal Geol. Soc., No. 81, p. 48.

reveal a structure resembling that of other Foraminiferal forms; as, for example, *Calcarina* and *Nummulina*. Dr. Dawson's description is accompanied by some remarks by Dr. Sterry Hunt on the mineralogical relations of the fossil (Op. cit., p. 67). He observes that, while the calcareous septa, which form the skeleton of the Foraminifer, in general remain unchanged, the sarcode has been replaced by certain silicates, which have not only filled up the chambers, cells, and septal orifices, but have been injected into the minute tubuli, which are thus perfectly preserved, as may be seen by removing the calcareous matter by an acid. The replacing silicates are white pyroxene, serpentine, loganite, and pyrallolite or rensselærite. The pyroxene and serpentine are often found in contact, filling contiguous chambers in the fossil, and were evidently formed in consecutive stages of a continuous process. In the Burgess specimens, while the sarcode is replaced by loganite, the calcareous skeleton, as has already been stated, has been replaced by dolomite, and the finer parts of the structure have been almost wholly obliterated. But in the other specimens, where the skeleton still preserves its calcareous character, the resemblance between the mode of preservation of the ancient Laurentian Foraminifera and that of the allied forms in Tertiary and recent deposits (which, as Ehrenberg, Bailey, and Pourtales have shown, are injected with glauconite) is obvious.

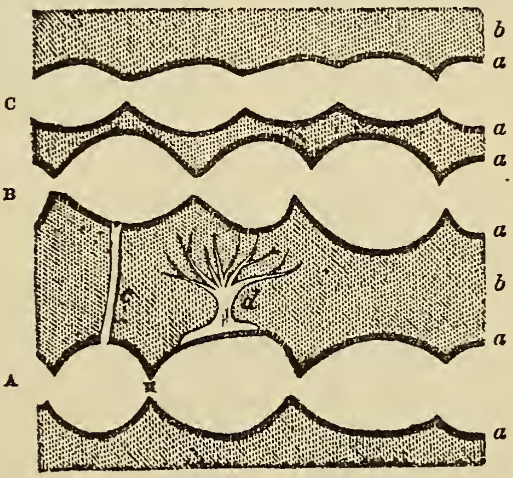


Fig. 2.—Diagram of a portion of *Eozoon* (after Carpenter).—A B C, chambers in three tiers communicating by more or less constricted passages, or (as in A) by a passage of two small openings; *a a*, the proper or essential shell, tubuliferous and thin; *b b*, intermediate or supplementary shell; *c*, Stolon-passage from tier to tier; *d*, Ramifying tubes (arising from a "lacuna") in the "supplementary shell."

There are, at least, three zones of crystalline limestone in the Lower Laurentian series (see diagram, fig. 1); the specimens from Grenville bearing organic structure belong to the highest of the three; and it remains to be proved whether the other limestones (as well as a similar marble in the Upper Laurentian) contain it also. The specimens from Burgess and the Grand Calumet have not had their places determined.

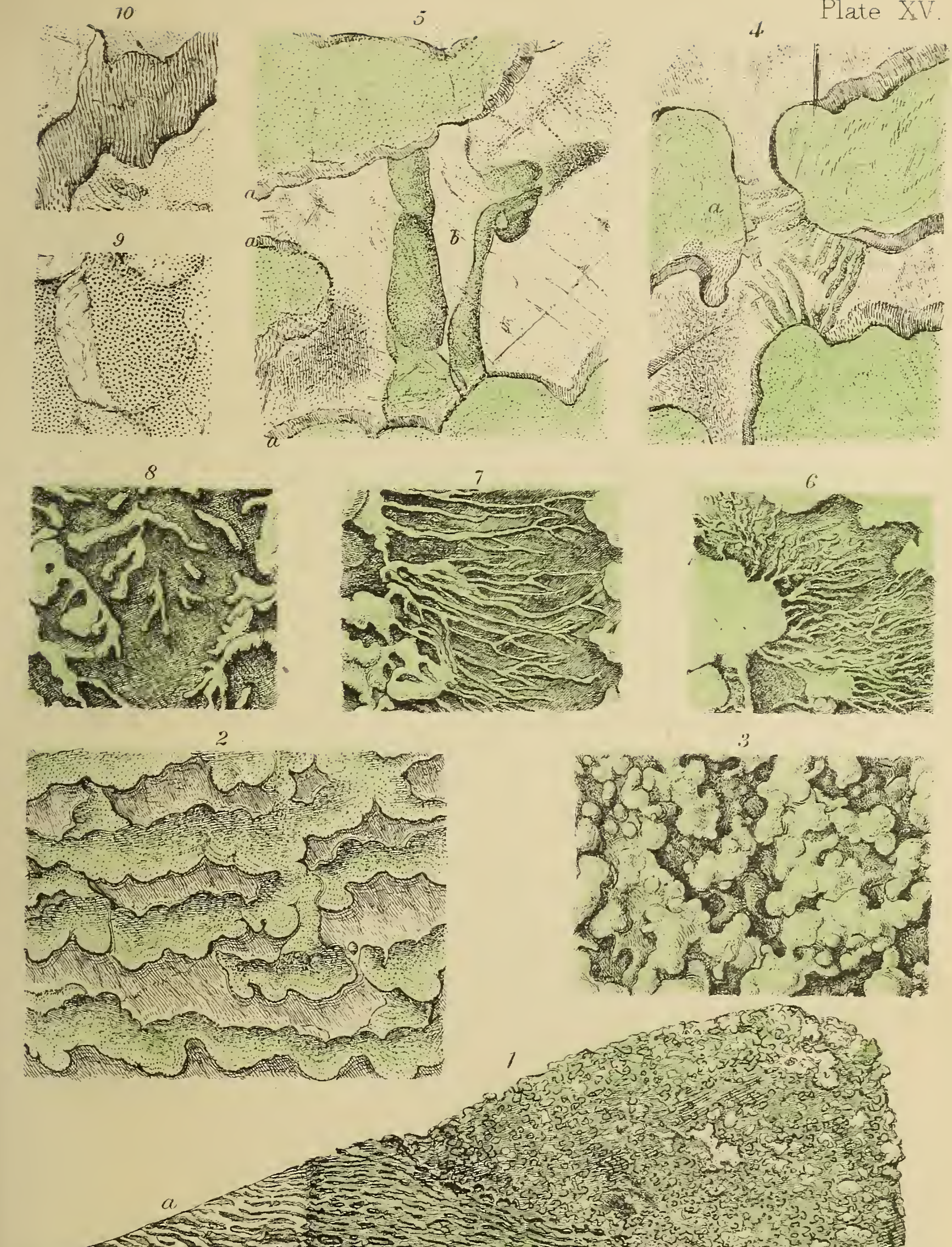
The zone of Grenville limestone (says Logan, *op. cit.*) is in some places about 1,500 feet thick; and it appears to be divided for considerable distances into two or three parts by very thick bands of gneiss. One of these occupies a position towards the lower part of the limestone, and may have a volume of between 100 and 200 feet. It is at the base of the limestone that the fossil occurs. This part of the zone is largely composed of great and small irregular masses of white crystalline pyroxene, some of them twenty yards in length by four or five wide; and they appear to be confusedly placed one above another, with many ragged insterstices and many smooth-worn, rounded, large and small pits and subcylindrical cavities, some of them pretty deep. . . . These masses of pyroxene may characterize a thickness of about 200 feet, and the interspaces among them are filled with a mixture of serpentine and carbonate of lime. In general a sheet of pure dark-green serpentine invests each mass of pyroxene, the thickness of the serpentine varying from the sixteenth of an inch to several inches, rarely exceeding half a foot. This is followed in different spots by parallel, waving, irregularly alternating plates of carbonate of lime and serpentine, which become gradually finer as they recede from the pyroxene, and occasionally occupy a total thickness of five or six inches. These portions constitute the unbroken fossil, which may sometimes spread over an area of about a square foot, or perhaps more. . . .

The general character of the rock connected with the fossil produces the impression that it is a great Foraminiferal reef, in which the pyroxenic masses represent a more ancient portion, which having died, and having become much broken up and much worn into cavities and deep recesses, afforded a seat for a new growth of *Foraminifera*, represented by the calcareo-serpentinous part. This in its turn became broken up, leaving in some places uninjured portions of the general form. The main difference between this Foraminiferal reef and more recent Coral-reef seems to be that, while with the latter are usually associated many shells and other organic remains, in the more ancient one the only remains yet found are those of the animal which built the reef.

Dr. Dawson's masterly exposition of the peculiar appearances seen under the microscope in the alternating calcareous and serpentinous laminæ in this peculiar marble, and of the relation of the first to a Foraminiferal many-chambered shell, such as still exist, and of the second to its segmented jelly-flesh (or sarcode) converted into a green silicated mineral, was based on a rigorous examination (with the light of Carpenter's "Researches on Foraminifera") of thin slices or films of the marble, and substantiated far more easily by the production of the silicated segments of sarcode and their connecting threads, by the removal of the calcareous or shelly matter by acid. Dr. Carpenter has not only had the pleasure of verifying (at Sir W. Logan's request, and with specimens supplied by him, *op. cit.*, p. 59) Dr. Dawson's conclusions, but of even adding to his almost exhaustive account of the structure of this curious fossil.

Our readers will already have been grounded in a knowledge of Foraminifera, their shells, their flesh or sarcode, their pseudopodia or threads of sarcode protruded through the shell, their mode of growth, habits, and place in the animal kingdom, by Professor Williamson's illustrated memoir in No. XIV. of this Review (p. 171, pl. 8); for further details they must go to Carpenter's "Introduction to the Study of Foraminifera," published by the Ray Society. It is sufficient here to state that a simple round atom of the living gelatinous matter, or sarcode, invested with an exquisitely thin shell of carbonate of lime, may be said to constitute a Foraminifer;

Plate XV.



Tuffen West, sc. ad nat.

Eozoon Canadense.

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the tiny shell may be traversed everywhere by extremely minute and numerous tubuli (like those of dentine), and may have larger tubes for larger threads or pseudopods to pass out, and a larger aperture for the sarcode to bud forth for the formation of a second little lump, connected by a "stolon," or neck, to the former; and this, when similarly coated with shell, either remaining distinct or turned back partly over the first, may produce the like again, and so on in succession, either in a row, straight or curved, cylindrical or tapering; or the gemmules may form segments (more or less enveloping one the other) in a flat or a raised spiral form, or otherwise; and may proceed from more than one aperture in the shell. Not unfrequently we find Foraminifera beginning with a flat spiral-chambered shell (corresponding to the segmented sarcode), and then adding chamber to chamber all round the edges, and even on the upper and lower surfaces, until the first regular stages of growth are hidden in the irregular and heaped ("acervuline") growth of chambers, or shelled segments, on all sides. Conditions analogous to—nay, even identical with, these, Dr. Dawson clearly sees in the vastly larger calcareous framework of his *Eozoon* (pl. 15, fig. 1); and though so much larger in its accumulated chamber-growth, row by row and tier on tier, yet its intimate structure is the same, and can be discerned only with the microscope "power" necessary to show that of recent Foraminifera. As in living *Polytrema, Carpenteria,* and others, the segments of sarcode are not neatly divided one from another, owing to their free manner of growth (chambers being scarcely marked out by divisional walls or "septa"), so in *Eozoon* the sarcode did not form regular segments or lobules of uniform or even definite shape (fig. 2), but grew out on every side luxuriantly, and only partially constricted by infoldings of the shell. Hence modified stolons appear, either single or multiple (passing through one or several holes in a septum, fig. 4, *a*), or as scarcely pinched necks between the segments (figs. 2 and 5).

Further, in *Eozoon* the shell appears in some places (at the base of each mass) as relatively thick laminæ, white and calcareous, with short, transverse, connecting lines of similar material (fig. 1, *a*); these shell-walls are thinner and thinner higher up in the fossil, for an inch or two, until both laminæ and cross-walls are extremely attenuated, disappearing from sight in the greener and granular upper portion, which was at first thought to be a ruinous condition of the *Eozoon*, but is really its "acervuline," or irregularly grown, portion (fig. 3). None of this granular or finely lobulated sarcode, however, is really without shell; and, as Dr. Carpenter has acutely observed, it possesses the essential shell-wall as much as the coarser, more regular portion. It is, indeed, only the first and excessively thin tubuliferous shell that is essential to this kind of Foraminiferal animal, which may grow and enlarge with this coating only; but usually, when it has attained some size, and is favourably situated, the shell is thickened by supplementary layers secreted at the surface by sarcode-threads passing through; and these, either straight, winding, or branched, wide-spreading or brush-like, keep passages open in the shell; hence the "supplementary" or "intermediate skeleton," or "vascular system," varying in development among Foraminifera and in individuals, according to circumstances. Thus every patch of *Eozoon* seems to have flourished with thickened shells, layer on layer, for a time, as shown by the laminæ of calc-spar permeated by branching threads (figs. 1, 6, 7, 8); and then the sarcode formed its innumerable gemmules and segments with less and less of the extra coating, until only the essential shell-wall, delicate and minutely tubular (figs. 5, *a*, 9, 10), separated more or less perfectly the heaped-up granular segments (fig. 3), and is now best recognized in the delicate velvety film of minute whitish perpendicular threads coating the dark-green granules.

The presence of this well authenticated Foraminifer in these lowest and oldest rocks clears away the error of regarding the "Metamorphic" rocks as having been formed originally otherwise than as sediments like sand, mud, and shell-rock, and the error of terming them "Azoic," or lifeless. They might, perhaps, be termed "Eozoic," as suggested by Dr. Dawson, if we may regard the *Eozoon* as really a creature of the *dawn*—but who knows? We are not sure these rocks are "Primary" in the strict sense of the word; indeed, they were made from the ruins of older rocks, probably once sediments themselves. Perhaps we had best keep to "Palæozoic," for they are *old* enough for certain. But is *Eozoon* alone in these deposits? Dr. Dawson says that he sees other things, like bits of Crinoids and Shells, and traces of Worm-burrows, in the Laurentian schists and limestones. The graphite too, and apatite, and iron-salts were probably not all due to Foraminifera alone, however widely and thickly spread. The curious, chambered *Eozoon* seems to have been filled with silicates of magnesia, alumina, &c., just as Foraminifera are filled in like manner with a silicate of alumina (glauconite) in the present seas, and as they have been filled in all seas Tertiary, Secondary, and Silurian; the differing contents of the sea-water at so widely distant times giving different silicates; and, thus preserved, their forms are found strewing the bed of the Mexican Gulf and of Australian and other seas in profusion. And further, thus accumulated, they may remain fossilized when the present geographical conditions shall have been altered, when the sea-bed has risen up with its accumulated coral-reefs and shell-banks; and, possibly, they may form a distinctive feature in the Geology of the future, remaining distinguishable as organic remains when shell and coral, mud and sand, shall have been squeezed and modified as obscure elements in the mazy entanglements of "Metamorphic" rocks! So the Eozoal limestones may be the only well-marked persistent organic witnesses of an old deep ocean, rich with life; whilst the inhabitants of the shallows, though of higher grades in life, have long since lost their individuality in the graphites, phosphates, silicates, and sulphides of the crystalline rocks.

Eozoon has its existing representatives as to its wild and accumulated growth, though not to such an extreme, in some well-known Foraminifers, by no means the lowest of their class; and in its shell-structure (which, as Dr. Carpenter well argues, is an essential character), its best representative is the highest of Foraminifers—*Nummulina.* Had it been found in existing seas, it would have been classed by Carpenter as a free-growing form of that genus. If, then, the lowest of the low are expected to be the first among the first, other and lower forms, such as *Miliolina* and *Orbitolites,* are yet to be found in the earliest rocks. This reminds us that a Silurian (and, therefore, later) fossil, known as *Receptaculites,* is made up on the plan of *Orbitolites* (as remarked by Carpenter), and that *Stromatopora, Archæocyathus,* and other obscure Silurian fossils (as Dawson has suggested), may have to be classed as Foraminifers of large size compared with existing forms, but not strange as to their structure.

Not only in Canada, but in Connemara is *Eozoon* found; and, doubtlessly, other serpentinous marbles may yield it, if looked for. The Laurentian formation is known to exist in Canada, North and South America, Norway, West Scotland and the Hebrides, Wales and Malvern, France, Bavaria, and Bohemia. In Leicestershire, Eastern Scotland, Ireland, India, and other places, many granites, serpentines, and associated schists will probably come out as Laurentian; at all events geologists have directed their attention to the matter, and cautious research will make all clear in time.

[Logan's Reports on the Geology of Canada; Bigsby's Memoir on the Laurentian rocks in the *Geological Magazine;* and especially Logan, Dawson, Carpenter, and Hunt's Memoirs on *Eozoon* in the *Geol. Soc. Quart. Journ.* must be referred to by those interested in this old and curious fossil.]

EXPLANATION OF PLATE.

PLATE 15. Illustrating EOZOON CANADENSE and its structure. (Partly after Dawson and Carpenter.*)

Fig. 1. Piece of Lower Laurentian Calcareo-serpentinous Marble, from Grenville, Canada; partly decalcified, showing tiers of the sarcode of Eozoon in the lower part, and acervuline structure above. The polished portion, not decalcified, is marked *a*.

„ 2. Portion of some tiers of Sarcode, decalcified. Magnified.

„ 3. Portion of an "Acervuline" portion, where the segments of Sarcode are arranged irregularly, decalcified. Magnified.

„ 4. Portion of *Eozoon*, seen by transmitted light, showing parts of chambers, the shell-walls, and (at *a*) some stolon-passages.

„ 5. Portion of *Eozoon*, seen by transmitted light, showing parts of chambers, showing (at *a*, *a*) the very thin *essential wall*, and (at *b*, *b*) traces of vertical stolons, passing from tier to tier. Magnified.

„ 6. Portion of decalcified Shell-wall, showing minute pseudopodial passages as threads. Magnified.

„ 7 and 8. Groups of branching threads, in the thick shell, decalcified. Magnified.

„ 9 and 10. Surface and section of a portion of *essential* Shell-wall in *Eozoon*, delicate and tubuliferous, like that of *Nummulina* and other Foraminifera.

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* I beg to acknowledge, with thanks, Dr. Carpenter's kind assistance in the arrangement and preparation of this plate, and in courteous communication of information relative to *Eozoon Canadense;* and to Sir W. Logan thanks are due for specimens.—T. R. J.

REVIEWS.

THE LARYNGOSCOPE.*

THERE are not many of our non-professional readers who know what a Laryngoscope is. It is an instrument to enable the medical man to examine the state of the larynx, and the larynx is nothing more nor less than that curious apparatus of cartilages placed at the back of the throat, and whose office is the production of different vocal sounds. The larynx it is which produces that marked prominence of the outer and front portion of the neck of man designated the *pomum Adami*, or Adam's apple. More strictly speaking, we should say that the thyroid cartilage causes the prominence to which we have alluded. Now this thyroid cartilage has attached to it the cords of the voice, those peculiar membranous bands which, by the action of the air upon them, develop the vocal sounds characteristic of the animal in which they present themselves. The shorter those cords are, the sharper and higher will be the voice, and conversely. Hence, as the cords increase in length, the thyroid cartilage, or Adam's apple, gets pushed forwards, and the voice becomes more bass; and for this reason we find that those persons who possess that powerful voice known as "basso profundo," have the most prominent *pomum Adami.*

The organs of voice are subject, like all other portions of our perishable frame, to several disorders, and till the invention and application of that interesting yet simple instrument, the laryngoscope, the treatment of these diseases was in great measure a matter of conjecture and empiricism. It would indeed be difficult to adopt a rational method of treating disease, if we were acquainted with neither its seat nor its character. Yet till recently physicians were unable to form accurate diagnoses of laryngeal maladies. The same thing might have been said of the eye some few years since; but the discovery of the ophthalmoscope has put the surgeon upon a tolerably satisfactory footing. Indeed, the application of natural philosophy to medicine seems to be quite the rule of the day, and already we have optical apparatus for the examination of the eye, the stomach, and the vocal organs. Dr. Morell Mackenzie has written the larger and more important of the volumes under notice. He is a gentleman well known to professional men for his devotion to the special subject upon which he has taken up his pen; and it would be superfluous therefore to say aught concerning his ability to discharge the duties of a teacher. Even those of our readers who are not members of the medical profession, but who have occasionally visited our local science *conversaziones* must have seen a gentleman sitting at a table with a lamp and an arrangement of mirrors and lenses before him, and displaying to a wondering audience the arrangement and operation of his own *chordæ vocales.* That gentleman was Dr. Morell Mackenzie. His book treats of the history of the discovery, the nature and optical qualities of the laryngoscope, and the mode of employing it in throat diseases. The instrument in its simplest form—that of a mirror placed at the back of the throat, so as to reflect to the eye of the observer the image of the glottis or air-passage, was employed by M. Levret, a distinguished French accoucheur, as early as the year 1743. From that period but little advance was made till, in 1804, a physician of Frankfort-on-the-Maine, Dr. Bozzini, announced his invention of an apparatus for illuminating the different canals in the body. This savant's instrument consisted simply of a pair of bent tubes, or rather of a single bent tube divided into two portions, and having two mirrors in the two angles thus formed; through one of these canals the light was admitted, and reflected to the larynx, and by the other the rays which had fallen upon the larynx were conveyed back to the eye of the observer. Feeble were the efforts made either to employ or improve the laryngoscope from the year 1804 up to 1829, when our fellow-countryman Dr. Benjamin Guy Babington exhibited, at one of the meetings of the Hunterian Society, an apparatus which closely resembled that now in use. "Two mirrors were employed by this physician, one, the smaller, for receiving the laryngeal image, the other, the larger one, for concentrating the solar rays upon the first. The patient sat with his back to the sun, and, whilst the illuminating mirror was held with the left hand, the laryngeal mirror was introduced with the right." The tongue having been depressed, the larynx could then be distinctly observed. Dr. Mackenzie considers that the instrument of Babington may be regarded as the first real laryngoscope, and hence that its inventor deserves the title of discoverer. The author does not omit to mention the claims of Garcia, and alludes to his important paper presented to the Royal Society. *En passant*, he hints at the want of enterprise which our countrymen sometimes exhibit. Writing upon this matter, he observes,—"Garcia's communication to the Royal Society, though causing little stir at the time, was destined to experience a fate in many respects similar to that which befell the paper of our countryman Mr. Cumming. Treated with apathy, if not with incredulity, in England, both papers passed into the hands of foreign professors, and whilst Helmholtz *matured* the ophthalmoscope, Czermak developed the laryngoscope."

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* "The Use of the Laryngoscope in Diseases of the Throat," &c. By Morell Mackenzie, M.D. Lond., M.R.C.S. London: Hardwicke. 1865. "The Laryngoscope: Directions for its Use," &c. By G. Johnson, M.D., F.R.C.P., Prof. of Medicine in King's College. London: Hardwicke. 1864.

Dr. Mackenzie's apparatus is somewhat similar to that of Dr. Babington. It consists of three distinct elements: a laryngeal plane mirror, which is small (about $\frac{8}{10}$ inch in diameter), and is held by means of a slender stem at the back of the throat; a second mirror, which is concave, with a focal distance of about 14 inches and a diameter of about $3\frac{1}{2}$ inches: this is perforated by an aperture in the centre. The third element is the illuminator, a contrivance devised by the author, and which consists of a chamber of lenses, which is so arranged that it can be attached to a common candle. The larger mirror may be attached to a spectacle-frame, and worn by the observer: with it he collects the rays of light from the condenser or chamber of lenses, and throws them on to the laryngeal mirror; this in its turn reflects them to the larynx; from it they again travel to the mirror; and from this they then pass to the observer's eye. Those portions of Dr. Mackenzie's work which relate to the healthy and morbid characters of the larynx and vocal cords display much careful research, and though of little interest to the non-professional reader, will be read with considerable advantage by the laryngoscopist. His chapters on the surgical operations for the removal of unhealthy growths, tumours, &c., are equally important.

The little *brochure* of Dr. Johnson contains a report of two lectures which this gentleman delivered at the Royal College of Physicians. Although the subjects it treats of are those which Dr. Mackenzie has dealt with in his larger volume, still they are presented to the reader in a somewhat different, and, if comparisons were not "oderous," we should say in a more familiar style. He points out the truth of what we have already stated; viz., the difficulty which heretofore attended the diagnosis of throat diseases. Quoting from Mr. Porter, who wrote in the year 1837, he writes,—"How is a man of experience, when he meets with a case of laryngeal disease, to know whether it is caused by an œdematous condition of submucous tissue, by the presence or absence of tumour, or by any other of these numerous affections which dissection so frequently shows us to be the occasion of death?" Well may he ask how. Indeed, till the employment of the laryngoscope, the answer invariably was, by no means whatever. There is one feature in Dr. Johnson's little book which deserves notice. A series of illustrations are given showing the relative positions of physician and patient during laryngeal examination. This is of much advantage to the student, and we think it is to be regretted that Dr. Mackenzie did not adopt a similar mode of illustration, for in *his* work, although the woodcuts are in point of execution the highest of their class, still they present in most cases portions of the apparatus, and in no instance have the entire apparatus with the patient and laryngoscopist been displayed together. We think too that in one instance there is some mistake as to the operation of lenses upon light; most probably, however, the error is one of the printer's. In page 45 of Dr. Mackenzie's treatise we find it stated, "that since, when rays fall on a convex surface, a certain number are *refracted* and do not pass through it, the plane face of a plano-convex lens should be placed next the flame." We presume that the word reflected was intended, as otherwise the meaning of the sentence is by no means clear. Both essays, however, are exceedingly good, and we commend them to the careful consideration of those who desire to know how to work with the laryngoscope. They are clearly written, abundantly illustrated, and as regards type, paper, and mechanical details, are excellent.

MICROSCOPIC ANATOMY.*

THOSE who are conversant with the progress of human Histology during the past five years are aware how much the labours of Dr. Lionel Beale have contributed to the advancement of this department of anatomical science. As the result of his numerous inquiries into the structural characters of the tissues, he was led some time ago to publish a peculiar view concerning the mode of development of animal structures. We believe this view, or rather an expression of it in the form of an hypothesis, was put forward first in the lectures delivered at the College of Physicians. These lectures were subsequently reprinted, but in a purely scientific form; and hence they appealed only to the members of the profession. The present volume, though of more moderate pretensions than the former one, and evidently intended for readers not immediately connected with medicine, still displays the author's ideas in very clear terms.

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* "On the Structure and Growth of the Tissues," &c. By LIONEL S. BEALE, M.B., F.R.S. London: Hardwicke. 1865.

The simplest of the human tissues consist essentially of two distinct elements—a clear structureless matrix, and numerous imbedded granular particles. The most important question in development refers to the origin of these two elements. Some histologists, at the head of whom stands Professor Huxley, regard the matrix as the organizing material, and look upon the granular particles as passive. Others, and especially the author of the volume under review, consider that the granular particles, which they term nuclei, as the active agents in the production of tissues. The theory, as expressed by Dr. Beale, regards the two constituents as being respectively formative and developed material. Hence, according to this doctrine, the granular matter is termed *germinal*, and the matrix is called *formed*. In so far as Dr. Beale demonstrates the non-existence of cells, properly so called, our opinions are quite in unison with his; but when he contends that the nucleus is the developing centre, we are not prepared to side with him. The chief arguments which he advances in support of his conclusions may, we think, be ranged as follows:—

(1.) Carmine solution tints the granular or nucleus portion more readily than the older portions of the other element.

(2.) As a tissue grows, the interspaces which exist between the nuclei increase in width.

These appear to be the more important facts tending to bear out the theory, and really we think they may be explained upon other hypotheses. For example, since the inquiries of Mr. Abbey have shown that the nucleus itself is not the only portion coloured by the action of carmine, but that this dye tints the adjacent structures in a characteristic manner, there appears some reason to doubt the force of the carmine-action view. The fact that the interspaces become increased does not seem to us to militate against the deposition theory. If we consider the nuclei as indicating portions of these minute channels which we know to pervade all tissues, we can then understand how the protoplasmic fluid perpetually flowing through them may, by constantly sending out material or pabulum, increase the actual bulk of the structureless internuclear substance. Yet this would not involve any special activity upon the part of the nuclei themselves. May not the nuclei be looked upon as the accumulation of larger molecules, which have separated from the protoplasmic liquid in which they were originally suspended? It may be urged that this is a pure speculation; but, after all, has it not something to support it in the absence of any absolute proof of the active operation of the nucleus? It cannot be denied that Dr. Beale has carried on his investigations with the aid of infinitely higher powers than those of other histologists—his employment of the $\frac{1}{25}$ inch and $\frac{1}{50}$ inch is sufficient proof of this. But, it may be asked, can such increased amplification of the elements of tissues throw proportionally greater light upon the complex questions of their development? The first chapter of the present volume is purely introductory, and in it we find one or two theories, and among them the old cell-doctrine discussed. In the succeeding pages the writer very carefully describes the structure of the several tissues which compose the human fabric. The section devoted to the connective series of tissues is especially important, and deserves a careful perusal. The descriptions of bone do not contain anything new, but the chapter in which the structure and development of teeth are described contains some new and startling views. The author distinctly opposes Professor Huxley's theory; and, as we think, from a misapprehension of the views of the latter. Conceiving, as it seems to us, that Professor Huxley regards Nasmyth's membrane as homologous with the basement membrane of skin, he proceeds to show that dentine is not a sub-basement structure. Huxley's views become clear enough when one thoroughly comprehends the value of the expressions or terms he employs; he has always discarded the use of the term basement membrane as calculated to confuse; and if, therefore, Dr. Beale assumes that the membrane of Nasmyth, which covers the enamel, is equivalent, in point of relation, to the basement membrane of skin, he is incorrect. We imagine that, if the two histologists employed precisely the same technical terms, and attached the same signification to them, there would be very little difference between their opinions as to this question. In regard to the concluding chapters, upon life and vital theories, we prefer to be silent. All modern research tends to explain the actions of the body by reference to physical laws. The existence of vital force is, on the contrary, purely hypothetical; neither party can give a full and rational explanation of the actions of living body; but we opine that the physicists are much nearer the truth than the advocates of a vital principle.

A YEAR AT THE SHORE.*

MARINE Zoology has found such an able and successful advocate in Mr. Gosse that it is only necessary to state that he has produced a new work, in order to procure for that work an extensive circulation. We can point to no writer upon Natural History whose pen has been so fertile, and withal whose books have been so popular and accurate. Mr. Gosse is well known to the working zoologist by the important observations he has made upon the habits and anatomy of the Infusoria, and also through his useful treatise upon the British Sea-anemones. To the amateur he is familiar as the author of "Tenby," "The Aquarium," "The Rambles of a Naturalist on the Devonshire Coast," "The Romance of Natural History," "Evenings at the Microscope," "Omphalos," and many other essays. In the beautiful volume which lies upon our table he has given the lover of marine zoology a complete seaside calendar. The chapters into which the book is divided correspond to the twelve months of the year, and in them we find descriptions, in Mr. Gosse's most attractive style, of the several creatures to be found at the sea shore in each month. Beginning with January, the author treats us to descriptions of the dog-whelk, pelican's foot, cowry, scallop, sea cucumber, and siponculus, each of which he depicts in glowing colours, tracing out their structure and mode of life, and here and there interspersing among the more zoological matter anecdotes concerning the superstitions connected with these animals. In this manner does he travel through the year till he arrives at the month of December. One who was ignorant of natural history would suppose that there was not much to be seen at so inclement a season; but the writer shows that even in dreary December there is occupation for the seaside rambler. He takes up the class Tunicata for discussion; and selecting, among others, the common squirter as an example, he proceeds to explain the curious arrangement of its parts:—"If we watch our Ascidia for a few minutes, we perceive that, at irregular intervals, one or both of the gaping orifices are suddenly closed or contracted, commonly both at the same instant. They are, however, soon opened again; and we may discern, especially if the specimen is in a glass vessel, and we watch it by the aid of a lens, with the light of a window at its back, that a current of the surrounding water flows from all sides to the taller orifice, and pours down its tube; while occasionally we see the ejection of a stream from the orifice of the shorter tube. Thus, we have here a receiving and a discharging tube—the exact representatives of the two siphons in such bivalves as Pholas, Venus, &c. The former leads down into a capacious sac in the interior, the walls of which constitute the breathing apparatus. The inner surface is marked by regular parallel ridges, which run in a horizontal direction; and these again are connected by vertical ridges at right angles, very numerous, inclosing a vast number of oval compartments. The sides of these are richly ciliated; and if the whole apparatus be carefully dissected out and laid upon the stage of the microscope, the course of the ciliary currents may be distinctly seen, continuing with unabated vigour and with unfaltering precision for a long time after the severance of the organ from the body of the animal." In a similarly graphic manner does Mr. Gosse describe the characters of the compound tunicates, *Botryllus* and *Pyrosoma*, and he then concludes the volume with what he terms a protest against modern error. This we regard as somewhat out of place. It is, no doubt, of advantage to be told "that we are by nature children of wrath; that the whole world lieth in the wicked one; and that the wrath of God abideth on it;" but we consider that there is a place for everything, and we cannot but regard Mr. Gosse's attempt to reanimate the old squabble between savans of the dilettante class and theologians of the dogmatic order as somewhat ill-timed. When the author confines his attention to the branch of science which his many labours so highly adorn, we read his volume with interest and profit; but when he comes to touch upon matters of a theologic turn, we cannot help regretting the course he adopts. After all, facts in Natural Science appeal to every cultivated mind, whilst it must be equally admitted that theological discussions of a special kind, though awakening a sympathy in some persons, may prove offensive to others. We yield to none in our reverence for the Great First Cause, and our admiration of the marvellous examples of His attributes as displayed in the works of Nature ; but we feel confident that, however good an author's intention may be—and of the excellence of Mr. Gosse's motives we do not for a moment doubt—there are many who regard the constant interlarding of scientific matter with scriptural phrases and quotations, as indicating at best a desire to be thought religious. Waiving these objections, the volume is an exquisite one, and is illustrated by thirty-six admirably executed coloured plates, in which the animals described in the text are, with a few exceptions, most truthfully delineated.

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* "A Year at the Shore." By P. H. Gosse, F.R.S. London: Alex. Strahan. 1865.

TERRESTRIAL PHYSICS.*

WHEN in any department of science we find certain laws established and almost universally admitted, and that the most celebrated men in the branch in question not only give credence to these laws, but constantly bring forward facts to support them and bear them out, we are not a little surprised to find some one who asserts that these laws are unfounded. In the little book which Mr. Hopkins has just issued, we are somewhat astounded to find that hitherto we have been travelling in darkness. Our knowledge has been faulty and full of error, and our mode of framing inductions has been unsound. Mr. Hopkins, however, in the true spirit of philanthropy, has determined to enlighten us. No longer shall we stray from the paths of truth, with the guiding light of his genius to point out the way. It is, indeed, a melancholy reflection, that in this, the second half of the nineteenth century, we have made such a slight advance toward a knowledge of the Statute-book of Nature. Is it not humiliating to find such men as Lyell, Ramsay, Murchison, and Logan existing in a very mire of ignorance ? Yet that such is the case Mr. Hopkins has assured himself. What Galileo did for Mechanics, Harvey for Physiology, and Newton for Astronomy, Mr. Hopkins bids fair to achieve for the future of Geology. The author of the volume before us returns to his native land, after a minute survey of the universe, including, of course, the less-distant planet, and, for the benefit of humanity, he expounds the comprehensive generalizations which his genius has unfolded. He does not do so from any desire of distinction. Friends who will read former essays occasionally press hard upon an author, and compel him, *nolens volens*, to appear again in the arena of literature. So did it fare with Mr. Hopkins. Anxious, after a lifetime spent in the investigation of natural phenomena, to retire, like another Cincinnatus, from the field of his fame, he was driven by friendly pressure to appear again before the public. "Having observed and studied these subjects for many years almost in every part of the world, solely for the love of scientific truths, he feels pleasure in communicating the results of his labours, for the benefit of those who have not had the opportunity of studying the world as it is," and "in order to show that the actual operations of terrestrial physics and geological changes do not warrant the extravagant speculations now entertained by geologists." If we were to proceed step by step through the several theories which our author proposes to substitute for existing ones, it would argue an absolute want of feeling for those of our readers who have been blind enough to adopt the current doctrines; we shall, therefore, confine ourselves to sketching Mr. Hopkins's theory accounting for what, in our innocence, we have heretofore simply regarded as the result of a change of climate. The presence in England of fossil plants akin to those of tropical countries was formerly explained by supposing that the surrounding conditions of this island were once such as to favour the growth of tropical plants. Indeed, there appeared to be every reason to believe that this was the true explanation. We already know that the climate of a country is by no means ruled by its latitude; that, for example, New Zealand and France, and Ireland and Newfoundland, though pretty nearly equidistant from the equator, have very different temperatures; indeed, Newfoundland, which is considerably nearer the equator than Ireland, is infinitely colder. Furthermore, an American gentleman, Dr. Sterry Hunt—with whose name, possibly, Mr. Hopkins is unfamiliar—has shown that the presence of a large quantity of carbonic acid in the atmosphere during Palæozic times may have impeded the radiation of heat from the earth, and so have increased its general temperature. These considerations led geologists to imagine, when they found tropical plants in English deposits, that such remains had not been transported from some other land. Our author is of a different opinion. In the earlier portions of his essay he shows that the outer crust of the earth is perpetually shifting,—in fact, that it rotates upon the inner mass, and is continually moving northwards at the rate 20″ per annum. By this discovery he cuts the Gordian knot which has puzzled geologists for so many years. The truth is simply this, England was formerly nearly under the equator, but by a simple process of shifting she has gradually assumed her present position. There is, however, one little difficulty which Mr. Hopkins seems to avoid, viz., the existence of the glacial period, which, according to his notion, ought not to have reached us so soon. It may, however, be conceived that the process of shifting was at one period carried on beyond its normal velocity, and that England was hurried into boreal regions before her time, and then rebounded to her present position. That we may not be accused of giving our author credit for extravagant notions such as those he so justly deprecates in geologists, we quote the following *exposée* of his views:—"Broken shells, fish, and floating carcases may be brought from the tropics by means of the currents of the ocean, and deposited along the coasts of northern lands; but, when we find forests of fossiliferous (!) tropical trees and plants, with *their roots attached to the soil in which they grew and flourished*, it is evident that the land in which they are now found must have been, if not within the limits of the mathematical tropical lines, at least in a region where such productions exist at the present day;" and, referring to the northern part of Africa, "the south of England must have been within that parallel about 3,000 years ago." We feel ourselves unable to penetrate the mysterious recesses of Mr. Hopkins's theory,—it is too comprehensive for our finite understandings, and we prefer, like our author, to "drink deep or touch not." Meanwhile, clinging to our old faith, we shall watch the Reformer's progress with the greatest interest.

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* "Cosmogony; or, the Principles of Terrestrial Physics." By EVAN HOPKINS, C.E., F.G.S. London: Longman & Co. 1865.

GEOLOGICAL ERRORS.*

We do not often find the sister island producing scientific works of much importance. Not that Irishmen are incapable of pursuing the higher paths of scientific study, for we find them taking an elevated position in all parts of the globe save in their own country. But in Ireland there is a lack of encouragement. The scientific institutions are disliked by certain sections of both religious creeds. Government gives little or no support, indeed it seems disposed to check the cultivation of science among Irishmen as much as possible. The chair of Zoology, which became vacant in the Museum of Industry three years ago, has not yet been filled up ; and the professorship of Natural History, vacated some six years ago in Belfast Queen's College, has been amalgamated with that of Geology ; so that the present professor, who certainly holds an honourable rank among scientific men, and deserves a better status than that accorded to him by a niggard ministry, is obliged to lecture upon Zoology, Comparative Anatomy, Botany, Geology, Palæontology, Mineralogy, and Physical Geography. Such is the manner in which scientific education is conducted in Ireland under Government auspices. If, therefore, as a result, we occasionally observe a most lamentable display of ignorance in matters of science, the rulers, and not the people, are to blame. Mr. Kelly, a geologist we believe of some local distinction, and who occupies the position of vice-president of the Geological Society of Dublin—a circumstance upon which we cannot congratulate that association, has given us a work of 300 pages, in which he endeavours to prove that the modern geological theories are groundless. He has given his book the title of "Errors of Geology ;" but had he termed it Errors of Geologists, we apprehend the designation would have been more aptly chosen. We say this because we conceive that his own remarks display only too truly how liable a shallow mind, trying to reason upon complex natural phenomena, is to fall into a method of illogical and hasty induction. The more striking portion of Mr. Kelly's views is that which refers to the origin of sedimentary rocks. It is, we may say, universally taught nowadays that the ordinary stratified rocks represent the débris of continents ; in fact, are made up of particles of matter washed from lands which formerly existed, and carried away into the ocean in the form of mud, sand, &c. Mr. Kelly does not admit this. Finding that even in any ordinary arenaceous deposit, the layers are of a different nature, that the pebbles form one lamina, and the fine grains another,—he conceives that they could not have been derived from the surface of the globe. To explain the fact, therefore, he evokes a peculiar hypothesis, viz., that sedimentary strata are really derived from the interior of the earth. Volcanic action commencing, let us say, in the centre of an ocean, causes enormous quantities of mineral matter to be belched up : these, then, falling into the water are gradually deposited at the bottom. The difference between the beds he accounts for by supposing the volcano to throw out coarse and fine

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[*] "Notes on the Errors of Geology, illustrated by reference to facts observed in Ireland." By John Kelly, Vice-President of the Royal Geological Society of Ireland. London : Longman, 1864.

material at different times. It is indeed a most ingenious hypothesis, and appears to agree with facts ; but then the pre-existing theory is more natural, and is at least compatible with what we see occurring every day, which Mr. Kelly's view is not. The author thus puts forward his opinions : "Grains of sand and particles of mud, derived from other rocks decomposed by sun, frost, and rain, and brought down as sediment in rivers, would form new beds or masses homogeneous in lithological character, and would not have the coarse grains sorted for one bed, and the fine mud for another. This alternation of hard and soft beds occurs in the older sedimentary rocks, in common with the recent trap rocks of Garrow Point. Both are apparently produced by subterranean agency, acting on materials of different natures, the basaltic layer thrown up in a melted state ; the sandstone beds, the materials of which were not so easily fusible, thrown up in the state of sand or mud, and all spread out on the bottom of the ocean in beds or layers, as already described." Mr. Kelly must excuse our telling him that he begs the entire question. He assumes that the matter borne down from the surface of land by rivers, is deposited in one homogeneous mass ; but every-day experience opposes this. Let the writer make a section even of a seashore gravel-bed of ordinary size, and he will find the fine silt in separate layers from the pebbles. When mineral matter is borne down to the ocean by the rapid current of a river, it is in great part held in suspension by the velocity of the current ; when, however, it reaches the sea, the stream ceases, and the suspended matter falls to the bottom ; the larger or heavier particles will sink soonest, and the finer mud will be the last to subside. Then again, after several strata have in this way been formed, the silt-like material must gradually be pressed into separate layers. It appears to us that Mr. Kelly's process of reasoning is by no means unlike the method by which he assumes mud to be deposited under ordinary circumstances. The heavier and more substantial arguments become mingled in the most heterogeneous and confused manner, with the lighter and more trivial ones, and those who would analyze the mental deposits which this gentleman's work exhibits, find no small trouble in estimating the means by which they have been formed. Who, for example, could form a clear notion of what the writer intended to convey in the annexed passage :—"If the grains of sand be imagined to have been brought from the external surface of the earth, and used to make up beds of rock, instead of having been obtained from the interior nucleus, in considering geological phenomena, as deduced from those different ways of obtaining the materials of beds, the train of reasoning is different, the conclusions drawn are different, and error probably put in place of truth, both in theory and practice." There is only one part of the treatise under notice which contains a display of justifiable scepticism. When Mr. Kelly contends that much of what is called "Old Red Sandstone" in Ireland is really carboniferous, we are disposed to agree with him. All the evidence, both geological and palæontological, supports his view of the matter. The Tower of Hook Promontory, in the co. Wexford, affords a beautiful natural section of the two systems, and shows that the carboniferous lies conformably in the Devonian, and passes so gradually into it that it is quite impossible to point out the beginning of one or the termination of the other. Besides the absence of the fish characteristic of the Old Red Sandstone, and the presence of thin seams of coal and several coal plants in the Irish

Devonian, abundantly support Mr. Kelly's opinion. If instead of writing a book upon the errors of geology, he had given us the results of his great practical experience regarding the relation and character of the Devonian beds in Ireland, he would have done more for geology and less injury to his own reputation.

FOR AND AGAINST TOBACCO.*

ALTHOUGH the researches upon the action of tobacco on the animal system, which the accomplished editor of the *Social Science Review* has just published, are in pamphlet form, they are not on that account of less importance or interest. Some time ago, Dr. Richardson contemplated reading a paper before the Social Science Association ; but, unfortunately, he commenced his inquiries too late in order to complete his paper in such a way as, on becoming fully conversant with the subject, he felt it deserved. Since that period he has made an extensive series of investigations upon the operation of tobacco-smoke upon the body, and these he has recorded in the pages before us. It is not often that we meet with a scientific man capable of carrying out original experiments, and of impartially analyzing the evidence adduced by other workers. These two qualities Dr. Richardson shows us in his pamphlet that he possesses in a high degree. Hence his remarks are worth listening to, and merit careful attention. Tobacco-smoke presents a far more complex composition than is generally imagined. In ascertaining the products of the combustion of the "weed," the methods heretofore adopted have been somewhat objectionable. It is one thing to place a quantity of tobacco in a retort, and submit it to destructive distillation, and another to place a cigar between the lips and cause its combustion by successive inhalations. The conditions both as to the supply of oxygen in both cases, and as to other matters, are totally different. If, therefore, we would discover the nature of the compounds formed whilst we smoke a pipe or cigar, we must resort to such an ingenious method as that contrived by Dr. Richardson. "I constructed," says the writer, "a small pair of bellows on a principle which made them act as the lips and chest of the smoker act in the process of smoking. The bellows, in these experiments, drew over the air in small whiffs ; part of the smoke produced by the combustion was allowed to escape from the mouth of the pipe or the lighted end of the cigar, as occurs in ordinary smoking ; while the remaining portion of the smoke, which in the man would be taken into the lungs, was drawn into the bellows and subjected to analysis." Having procured the smoke by these means in precisely the same state as it is found during smoking, it was analyzed, and found to contain the following ingredients :—Carbon, ammonia, carbonic acid, water, and a peculiar oil. The latter, upon further examination, proved to be made up of three distinct components—a fluid alkaloid called nicotine, a volatile empyreumatic substance, and a resinous extract of a bitter flavour. These, then, are all the substances which a proximate analysis of tobacco-smoke demonstrates. Let us see what are their respective effects. The carbon, which is merely a fine variety of soot, simply attaches itself to the mucous membrane of the mouth, throat, and possibly air-passages, rendering them of a blackish hue, which, after increased development of epithelium, becomes thrown off; this is, therefore, not a very injurious element. The ammonia comes next; it is the material which parches the mouth of the smoker, stimulates the salivary glands to action, and which produces that feeling of drought that renders it a familiar saying that "smoking leads to drinking." These, according to Dr. Richardson, are not its only effects: it produces an alteration of the blood by operating upon the blood globules; these become shrivelled at their edges, and the whole blood becomes more liquid. This is a serious assertion. We do not mean in so far as it touches on the action of tobacco smoke *tout entier* upon the blood, but inasmuch as it refers the liquefying and impoverishing action to the ammonia. The writer some years ago produced an admirable essay upon "The Cause of the Coagulation of the Blood," in which the view was advanced that the fibrine of the vital fluid is kept in a state of solution by the influence of ammonia, and that when blood was drawn from the body the ammonia evaporated, and the fibrine assumed the solid form. May it not be that he has effected too close an application of this theory to the case now in point? We really cannot see that he is fully justified in attributing the blood-changes to the quantity of ammonia inhaled by the smoker. However, as we ourselves have made no experiments upon the subject, our remarks are only intended to be suggestive. The carbonic acid, which is produced in considerable quantity, is supposed by the author to cause those sensations of sleepiness and lassitude which follow the prolonged inhalation of tobacco fumes. The water cannot be productive of any decided action. The oil, —which is familiar to every smoker as the substance which eventually gives his pipe that colour which is so highly prized by those who indulge a fancy for "meerschaums,"—being compounded of three different principles, it becomes necessary to consider the effect of each of these separately. The volatile element is that which gives rise to the unpleasant odour of a bad form of tobacco, and the delicious perfume of a good cigar. This it is, too, which, in its partially decomposed condition, hangs about the clothes of a smoker, and about the curtains of the room in which he indulges what some consider his vicious propensity. It may be said to cause no injurious effects upon the body. The two other substances are, without doubt, those which in excess are productive of the marked poisonous action of the plant. These differ not only in physical character, but in physiological action; there is, too, a distinction to be drawn as to the frequency with which their action is exhibited. The bitter principle, though causing a more immediately unpleasant result than the alkaloid, has no such dangerous qualities as the latter. It is a resinous substance, which gives to the cigar or tobacco its flavour, and which is so largely present in those specimens of the weed which the tobacconist terms *strong* cigars, as distinguished from *mild* ones. Its action is upon the stomach, which it stimulates to reverse peristaltic movements, thereby producing in some cases, especially in young smokers, violent vomiting. It must not be inferred from this that it has simply a direct action on the stomach: we presume, though Dr. Richardson does not say so, that it operates on the digestive sac through the pneumogastric nerve; for there can be little doubt that in most cases of vomiting the result of smoking, head symptoms—giddiness, &c.—present themselves prior to the convulsive contraction of the stomach. We entirely concur in the writer's opinion that nicotine is not "the author, one and indivisible, of the smoker's pleasures and pains." This view is borne out amply by Dr. Richardson's inquiries; and we think that his experience fully supports the following statements:—"Nicotine, though one of the most potent substances, is the last, owing to the smallness of its amount and its little volatility, to exert effects on the smoker. It is only, in fact, after prolonged smoking that it reaches the blood at all; then, truly, it becomes the most active poison of the group, exciting symptoms which are at all times dangerous, sometimes fatal, and which, but for the rarity of their occurrence, would have excluded tobacco as a luxury at its first origin, without any aid from the moral crusaders against the weed." We wish our space permitted our following Dr. Richardson through his lucid description of the action of tobacco-smoke generally upon the system. In these we find that depth of thought and analytical power for which the writer is remarkable constantly displayed. Drawing from his stores of physiological knowledge, he has thoroughly sifted and replied to the several questions concerning the production of disease by tobacco-smoke, and to each and all he has given a negative reply. Does smoking produce cancer? No. Or consumption? No. Or loss of sight, smell, or hearing? No. Such are Dr. Richardson's answers, upon the assumption that the habit of smoking is not carried on to excess. In reasoning with scientific men, the writer must certainly gain his cause, though he is by no means a special pleader. There is somewhat more difficulty in convincing those who are ignorant of science, and are sceptical as to its results. For these he has a word or two which cannot fail to show the weakness of the anti-tobacconist views, and which we quote for the benefit of our readers:—

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* "For and Against Tobacco." By BENJAMIN WARD RICHARDSON, M.A., M.D., &c. London : John Churchill. 1865.

> "Put down the smokers of Great Britain at a million in number—they are more than that, but let it pass—Why should there exist perpetually a million of Englishmen, not one of whom can at any moment be writ down as in perfect health from day to day? Why should a million of men be living with stomachs that only partially digest, hearts that labour unnaturally, and blood that is not fully oxydized? In a purely philosophical point of view, the question admits of but one answer—viz., that the existence of such a million of imperfectly-working living organisms is a national absurdity—a picture which, to a superior intelligence, observing the whole truth and grasping it, would suggest a mania, foolish, ridiculous, and incomprehensible."

These remarks, though forcible, are but just; and those who have carefully travelled over the pages of Dr. Richardson's brochure will admit their truth. The author has striven to achieve a good object, and every smoker should read his pamphlet.

OUR WINES.*

ADMITTING that wine should hold a rank in the scale of aliments, we may say that there is no branch of dietary upon which so much has been written and so little taught. We could instance a score of treatises upon Wine, the Vine, and the Grape, and yet in not one of them is the subject properly handled. It is one thing to write a lively, chatty work upon the subject of wines—any one possessed of a facile pen and means of compiling can do this,—but it is no such easy task to write a book in which the respective actions of the several species of wines are accurately discussed. We think we may safely assert that in no instance has the latter result been achieved. Mr. Sheen's production does not form an exception to this general statement. It is an interesting, amusing little volume, in which those who like to know something of the history of wines, their preparation and poetry, will find much information. We may add, too, that, since the book is in great part composed of matter drawn from previously published essays, it gives the reader a comprehensive glance at the whole literature of the subject. When Mr. Sheen confines himself to compiling facts, he is very successful, and dresses his matter in simple but pithy language; but when he strays into the wider domain of philosophical induction, he commits himself deplorably. To those familiar with chemistry, the statement that beer does not owe its inebriating property solely to alcohol will appear rather startling. If the writer confounds the stupefying quality with the truly intoxicating, then he may be right, inasmuch as the bitter principle of the hop possesses a narcotic action; but he is by no means clear on this point. Again, when speaking of the action of the German wines in preventing the formation of calculi, he falls into some sad mistakes. Liebig, Prout, and others attributed the medicinal results to the action of these wines in forming soluble salts with the mineral materials which form calculi; but Mr. Sheen has an idea of his own upon the question, and he does not hesitate to put it forward. It is this: in these countries "mothers are continually dosing their children with magnesia, which, being insoluble, forms dangerous concretions in the bowels, and lays the train for the formation in after-life of stone and calculus." Really we must be pardoned for telling the writer that he has formed a very startling and extraordinary theory. How, if magnesia is insoluble, can it be taken up into the system in order to form calculi? Admitting its insolubility, how does it contrive to surmount the trifling anatomical difficulty of passing from the alimentary canal to the vesica? and what is the nature of the curious "train" to which he refers? Although we have found some faults in the volume which Mr. Sheen has issued, we regard it, on the whole, as a well-written, pleasant little book, by no means scientific, but filled with an amount of information which the general reader will hardly find embraced by any single work of its class. We believe that the production of treatises of the kind is "more honoured in the breach than in the observance," and therefore our strictures must be considered by the author as for the most part applicable to the entire race of vinous literature.

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* "Wines and other Fermented Liquors," &c. By James Richmond Sheen. London: Hardwicke. 1865.

SCIENTIFIC SUMMARY.

AGRICULTURE.

The Utilization of Sewage may be regarded as the only important matter connected with farming which has received much attention during the past quarter. Several pamphlets have been written upon it, each one suggesting a different means of reducing the sewage to a condition fit for transport. The more general view, however, as elicited by the debate in the House of Commons on Lord R. Montague's bill, appears to be that the sewage must not be deprived of its watery element. In Cornwall, where enormous quantities of clay are transferred from one place to another, it has been found necessary to mix the earth with water, in order to facilitate its conveyance. In this state it has been transmitted through tubes, and, strange to say, at a considerable reduction of the expense formerly incurred when it was carried by other means in its solid state. Among the many pamphlets which have been addressed to the British public in relation to sewage, there is one which stands out prominently from its fellows, in the circumstance that it contains powerful arguments against the utilization of this material. It has been written by Dr. Spencer Cobbold, the well-known investigator of intestinal worms; and from the fact of its viewing the subject from quite a new standpoint, it is of interest. Zoologists know that the common tapeworm of man, which we may select as an example of the more generally distributed entozoa, is propagated by eggs which must undergo the first stages of their development in the bodies of some of the lower mammals. In the present state of things, the ova of this creature, which may be computed for London at some millions per annum, are yearly, ay daily, washed away into the Thames, and are thus destroyed. If, however, says Dr. Cobbold, you spread the sewage over the country, you will supply these ova with the conditions favourable to their development. They will be swallowed by our domestic animals, will in them complete the earlier stages of their growth, and will eventually take up their abode within ourselves. Thus, by distributing the sewage over our farms we will be literally adding fuel to the parasitic fire. This will go on increasing every year till, in course of time, the whole population will become infested by these creatures, and then it will be too late to cry out for assistance. It appears to us that Dr. Cobbold very greatly exaggerates the danger, for that there is a risk no reasonable naturalist can deny. In the first place he should remember that there is every probability that the great bulk of the ova would perish before finding the requisite condition for their development. Secondly, it must be admitted that an improved system of feeding our cattle would do away with much of the liability to entozootic diseases. Still we must confess that there is a serious danger to the population involved in the utilization of sewage as already proposed, and there is every credit due to Dr. Cobbold for being the first to call attention to it. Some time ago Dr. John Harley discovered that one of the most formidable entozoa with which we are acquainted, the *Bilharzia,* had been introduced into this country by some colonists who had returned from the Cape of Good Hope. Now this Bilharzia is an awfully destructive entozoon, and commits dreadful havoc among the Egyptians : out of 363 *post-mortem* examinations conducted in Egypt by Dr. Griesinger, this parasite was found in 117 cases. It usually takes up its habitation in the blood-vessels, and gives rise to most painful symptoms, followed in the more advanced cases by extreme prostration and death. We say it has been introduced into England; happily it has not spread over the country ; but, writes Dr. Cobbold, " once let this distribution commence as a consequence of egg-dispersion on any extended scale, and I know of nothing calculated to prevent the rapid spread of the endemic amongst us. Such a scourge would add yet another serious local ill to the already formidable list of evils to which our British flesh is heir." We do not think that Dr. Cobbold's exhortation is likely to prevent the utilization of the sewage, but at all events it may lead to the adoption of some means by which the ova may be destroyed while in the tanks.

ASTRONOMY.

Orbit of Sirius.—Mr. Auwers has recalculated the elements of the orbit of this remarkable star, which is now more interesting even than it was previously. He finds for its time of revolution round the hypothetical companion a period of about fifty years, moving at the rate of 7¼ degrees per annum. Its passage through its lower apsis occurred in 1794. Assuming the mass of the companion to be nearly one-half that of the principal star, he finds that at the present time the distance of Sirius from the common centre of gravity of the binary system is about 3½ seconds. Comparing his deductions with the places of the companion of Sirius discovered by Clark, the diminution of the angle of position of the large star is very perceptible, and agrees well ; but those of the observed distances are more doubtful, as might be expected. In one observation by Mr. Lassell, the distance is given as less than five seconds ; but in a subsequent one he is in agreement with the eight other observers. The difficulty of the measurement between the brightest star in the heavens and one of the faintest hidden in its rays, may easily be conceived ; but the present observations prove the truth of Sir J. Herschel's remark, that the angles of position are more to be relied upon than the measures of distance.

Diameter of Sirius.—The incongruous results attending the measurements of the diameters of stars has long been a subject of complaint, and it is yet doubtful whether any probable approximation can be arrived at. Sir W. Herschel made use of mists and fogs in order to diminish the intensity of their light, and thus concluded that the diameter of *Arcturus* was about one-tenth of a second. By a more artistic arrangement, M. Chacornac has reduced the diameter of Sirius to an almost imperceptible point ; for with the highest powers this star does not appear *larger* than a star of the twelfth magnitude. In order to produce this effect, he makes use of a double-image prismatic eye-piece. Two images of the star are thus obtained, which are placed in juxtaposition, so that the circumferences of the false discs touch. By then making use of the rotary prisms, the ordinary image is left in its original state, whilst the extraordinary one is gradually extinguished, those fringes and rings which surround it disappearing first. It will at last be found that the spurious disc becomes successively smaller, and that it is finally possible to reduce the apparent diameter of the star to an almost imperceptible point, or to that of a star of the twelfth magnitude. It is thus seen that the disc is quite factitious, and due altogether to the brightness of its light. When the brightness of a planet is diminished in a similar manner, no change is remarked in its diameter; and the same applies to the smaller planetary objects, as the satellites of Jupiter, which more resemble the sidereal bodies.

Sun's Photosphere.—From a strict examination of the sun-pictures obtained at Kew, and from Mr. Carrington's maps, Mr. De la Rue and assistants have arrived at the conclusion that the sun-spots are cavernous, and lie below the general level of the luminous surface, whilst, on the contrary, the faculæ are elevated above the latter. The reason that the faculæ appear brighter is, that on account of their height above the solar surface, they are less dimmed by passing through its atmosphere. They further conclude that the sun's luminous surface is of the nature of cloud, and that the spots are influenced by the planet *Venus*. They find that the faculæ retain nearly the same appearance for days together, and consider them to be small particles of solid or liquid matter in suspension, and composed of the same cloudy matter as the luminous surface of the sun. They notice that in the majority of cases the faculæ appear to the left of the spots, as if they had been abstracted from them, and, rising to a greater elevation where the velocity of rotation is greater, are consequently left behind. They remark that all the spots which are seen on the solar surface about the same time show a resemblance to each other; for instance, if one spot increases to the central line or past it, another will do the same; if one spot diminishes from its first appearance, another will do the same; if one spot breaks out on the right half, another will do the same. The influence of the planet Venus from without is suspected from this circumstance. It appears from Mr. Carrington's pictures, and all the Kew pictures, that the influence of Venus is exerted in such a manner that as the spots approach the neighbourhood of this planet by rotation they decrease; but as the solar surface passes away in the same manner, this influence causes it to break out into spots on the opposite side. The question is also proposed, whether the falling behind of the faculæ may not be the physical reaction of the motion of the spots detected by Mr. Carrington, the current passing upwards and carrying the luminous matter falling behind, whilst the current coming down from a colder region moves forward, carrying the spot with it, and accounting for its deficient luminosity.

Penumbræ of Solar Spots.—In the course of last year Weisse noticed two spots, both bordered by penumbræ, one of which was partly concealed by the penumbra of the other. This observation, which would be a very strong argument in favour of the superincumbent cloud theory, has been called in doubt by Mr. Howlett, who noticed the spots on the same occasion, and who states that the appearance was due to their unusually mottled and patchy aspect, "exhibiting a disposition to run into wavy bands of different degrees of luminosity, or the contrary." The wavy bands affected the whole of the penumbræ, and not merely such parts as might overlap.

Nebulous Star.—The changes of position of a star in respect to the nebulous star 45 IV. Geminorum, would seem to show, according to MM. Webb and Knott, that either is in motion. According to Sir J. Herschel and Admiral Smyth, the companion star was formerly north-preceding, whilst at the present time it is in the north-following quadrant. The positions given by Dr. Argelander agree with those given by MM. Webb and Knott.

Appearance of Mars.—Mr. Joynson has narrowly observed the aspect of Mars during the opposition of 1864, taking care that his observations were entirely original, and avoiding to look at or compare his drawings with any previous delineations. He found, however, that very little change had taken place since the previous opposition, only that the southern snow-point has not been visible, and that more of the northern hemisphere has been observable, though he has not perceived any snow at the northern edge of the disc, but only a dark expansion of a channel from the band observed during the last opposition. He notices, as before reported by him, that the band, with the exception of one break in it, is continuous round the planet, and has branches that passed apparently to each pole, and that it is permanent.

New Variable Star.—M. Schönfield has detected a star in *Leo Minor*, whose position is R.A. 9h. 37m., and north declination 35° 6′, which he finds to be variable between the 7th and 11th magnitudes, but the period of which is still uncertain. In relation to this subject, Mr. Chambers suggests that the old system of marking those objects (as R. Leonis, T. Virginis, &c.) should be rejected, and the old black letter capitals and small type made use of, which would give a range of forty-eight letters for each constellation.

Encke's Comet.—This celebrated periodic comet will come into view during this spring and summer. Mr. Farley has calculated an approximate ephemeris of it for this opposition.

Comet I. of 1864.—Mr. Tebbutt, of New South Wales, has calculated an orbit of this comet, which was independently discovered by him on the 10th of August, having been previously observed in Europe. It was remarkable for its proximity to the earth during the first week of August, for its small inclination to the ecliptic, and its near approach to the earth's orbit at the descending node. There is no other comet which resembles it in the catalogues. In respect to the spectrum of this comet, Professor Donati states that "it resembles the spectra of the metals; in fact the dark portions are broader than those which are more luminous, and we may say these spectra are composed of three bright lines, showing the existence of some close relation between nebulous and cometary matter."

Accuracy of Star Catalogues.—Mr. Stone concludes from a method devised by him for separating the errors arising from systematic instrumental errors (whether due to the rate of the clock or the position of the transit instrument), and those of the assumed right ascensions of the standard stars used at Greenwich, that the catalogue of stars, known as the Six-year Catalogue, is considerably more accurate than the previous Greenwich twelve-year one, partly due to the greater correctness of the places of the standard stars as determined by the latter, and partly to the greater stability of the new transit-circle, which was employed in the observations of stars included in the former work. The last catalogue issued from the Greenwich Observatory, known as the Seven-year Catalogue, he considers even more accurate than the Six-year one, and claims for it a high position among standard catalogues for the great accuracy of the fundamental right ascensions. The stars of reference chosen by him in conducting the investigation, were Eta Pegasi, Pollux, Spica, and Alpha Aquilæ.

Transit Instruments and Transit Circles.—Professor Airy institutes a comparison between the transit instrument as formerly employed and the present non-reversible transit circle, which is alluded to in the last paragraph. Even in the small points of difference of the flexure in the cones of support or of the telescope tube, he finds that when the error of the horizontality of the axis is obtained by a spirit-level, that in the old construction, although the optical axis may describe a great circle and a meridian, it may not be the meridian of the place, whilst by using a surface of mercury, as must be done in the Greenwich instrument; this is obviated. But the more important advantage of the non-reversible instrument is that the same pivot is always in the same bearing; and thus its action is more accurate, whilst at the same time the determination of the forms of the pivots is much less complicated than with the reversible form. In the determination of the level-error by means of a spirit-level, the difference of the diameters and forms of the pivots and of the angles of the forks of the level must be taken into consideration in the latter, but are not required when using the reflected image of the wires in mercury.

Semidiameter of Venus.—Mr. Stone has made a new determination of this element, making use of the vertical diameters observed with the old mural circle at Greenwich between 1839 and 1850, and those with the transit circle between 1851 and 1862; the former being 219 in number, the latter 370. He divides them into two groups, viz., when the observed diameter is greater than twenty seconds, and when it is less than that quantity. The former gives as the semidiameter of Venus, at the mean distance of the Sun from the Earth, 8,560 seconds of arc, the latter 8,427, with a small probable error. The mean would therefore be 8,472, which is larger than the value adopted in the Nautical Almanac (8,250), or that found by Encke from the transits of Venus.

Mr. Lassell's Observations at Malta.—In a letter, dated December 31, 1864, Mr. Lassell gives a *résumé* of the observations made during his residence at Malta. Numerous measures have been made of the diameter and satellite of Neptune. In regard to the latter, Mr. Lassell is firmly convinced, from the ease with which it is seen even in bright moonlight (especially when it is more than eight or nine seconds central distance from the planet), that the planet is attended by no other satellite—at least by any whose brightness could be compared to it, or equal to that which *Dione* or *Rhea* bears to *Titan* among Saturn's satellites. It may be possible, however, that a very distant one exists. In respect to the satellites of Uranus, Mr. Lassell has the fullest conviction that the two satellites discovered by Sir W. Herschel in 1787, with the two discovered by himself in 1851, are the only ones which accompany the planet. The two interior satellites last mentioned are very much fainter than the satellite of Neptune; but he has had no difficulty in observing them even in moonlight. Many observations have been made of the satellites of Saturn. In measuring the distances of the satellites, Mr. Lassell finds that by noting the times when they have reached elongations equal to the semidiameter of the ring, the observations are more trustworthy than by making use of the micrometer. He thinks that if this plan were introduced, it would lead to a knowledge of the more exact dimensions of the rings and their eccentricities. A series of drawings have been made of Mars, and delineations of the more remarkable of the planetary and other nebulæ, including one of the great nebulæ of Orion. Several new nebulæ have been detected by Mr. Marth.

New Comets.—A comet was discovered by M. Baecker, of Nauen, on December 15, of the brightness of a star of the 7th magnitude. Its motion was direct, and it passed its perihelion on December 22. The fifth comet of 1864 was detected at Leipsic on December 30, 1864, which passed its perihelion on December 27, and the motion of which was retrograde.

Radiant Points of Shooting Stars.—Mr. Herschel observed carefully the above in September and October. One he found to be at R.A. 82°, with 50° of N. declination, the other at R.A. 12°, and 2° of S. declination. The average time of duration of the first was 0·71″, and that of the latter 2·13″; and from other considerations he assumes that their velocity was as 3 to 1. If their distances in their orbits from the sun were one-fourth greater or one-fourth less than that of the earth's distance, this would be accounted for by theory. He therefore thinks, with Professor Newton and others, that the August and November rings of meteors very nearly coincide in their dimensions with the orbit of the earth. It also adds weight to the opinion, that their orbits are nearly circular, although it offers no explanation of their frequent retrograde motions and large obliquities to the ecliptic.

Spectrum of Epsilon Piscium at the time of Occultation.—On January 4, 1865, Mr. Huggins directed the telescope furnished with spectroscope to the above phenomenon, in order to detect, if possible, any symptom of a lunar atmosphere. If such existed, and absorbed any of the star's light, this would be indicated by fresh dark lines immediately before the star was occulted. If aqueous fog or invisible vapour existed, the blue rays would fade and the red ones be comparatively undimmed. If the lunar atmosphere were free from vapour, but rather dense, the blue end of the spectrum would continue visible after the red rays had disappeared. No change, however, took place in those respects. The spectrum disappeared (as if an opaque screen had passed over it) in two-tenths of a second. A few seconds before it disappeared, some lines were perceived in the red rays, which might however have belonged to the star. The results of the observation are therefore negative, although Mr. Huggins is careful to guard against the idea that he thinks it conclusive. The care taken by Mr. Huggins, and his experience in those matters, are already well known by his spectrum observations on the planets and some fifty fixed stars, as well as on the nebulæ. He has discovered some eighty lines in the spectrum of Alpha Orionis, in which only some dozen had previously been seen, whilst his observations on the spectra of the nebulæ have resulted in the great probability of the truth of the oft-combated "nebular hypothesis," as they now appear to be vast masses of luminous gas On this latter point, in so far as regards the nebula of Orion, which he has examined during this winter, Mr. Huggins is at issue with Lord Rosse and Professor Bond, who have detected stars near the trapezium which the spectrum apparatus only shows as a gaseous mass.

New Telescope.—Mr. Cooke has commenced a refracting telescope of the extraordinary dimensions of 25 inches aperture.

Professor Bond.—On February 10, the Gold Medal of the Royal Astronomical Society was presented to Professor Bond for his great discoveries in practical and theoretical astronomy. It never reached him, however, as he died on February 17, at Cambridge, U.S.

BOTANY.

Vegetable Hybridity.—On this subject a most interesting memoir was recently presented to the French Academy by M. Naudin. This distinguished botanist has been experimenting on certain members of the genus *Mirabilis*, and has arrived at some very curious results. In 1862 he obtained a plant and seed of *Mirabilis longiflora—Jalapa*, which had been procured by impregnating the common purple-flowered Marvel of Peru with the pollen of *M. longiflora.* The seed was sown, and the two plants grew to a large size, perfectly similar in every respect, and intermediate between the parent species. They were moderately fertile, and furnished some hundreds of perfect seeds. From seeds of the first plants M. Naudin raised six other hybrids of the second generation. They did not resemble the hybrids of the first generation either in size or appearance. Two of them were nearly alike ; they were vigorous, and flowered abundantly, but were quite barren. A third had almost reverted to the *M. Jalapa*, differing chiefly in the longer tube of the corolla : this was fertile. The remaining three were very dissimilar in their appearance, and barren ; at least they produced only a few fruits, in which the seeds were imperfectly formed. From a great number of somewhat similar investigations M. Naudin concludes that in all cases of hybridity where the plants do not revert to the parent type, there is an extreme of disordered variation exhibited.

Relation of Stamens and Pistil in Lythrum.—Some time ago, Mr. Charles Darwin sent a paper to the Linnean Society, in which he described the relation of the elements of sexual apparatus in this plant. The common *Loosestrife* appears to be trimorphic ; that is to say, it presents three modes of arrangement of stamens and pistil in different plants. These are the *long-styled*, *medium-styled*, and *short-styled.* The first has six medium stamens and six short ones ; the second has six long and six short stamens ; and the third has six long and six medium stamens. Now besides these differences in the length of the stamens, there are as many corresponding differences in the length of the styles ; viz., the long, medium, and short style. Mr. Darwin, with a patience for which he cannot be too highly praised, produced eighteen artificial unions by fertilizing each kind of stigma with the pollen of the six separate sets of stamens. From these researches he learnt that, as in structure, so in function, there are three female organs; for when all three receive the same pollen they are acted on differently; and, conversely, the same holds good with the three sets of stamens. The experimenter has also pointed out many other facts of the highest interest to physiological botanists, but for which we must refer our readers to his paper in the *Journal of the Linnean Society*, vol. VIII. p. 169.

Varieties of Spermatozoids.—According to the conclusions arrived at by Schacht, in a monograph, published last year, there are present in the vegetable kingdom three distinct and typical forms of spermatozoids. (*a*) Those found among the *Algæ*; (*b*) those of the *Equisetaceæ*; and (*c*) those characteristic of the *Characeæ*. There is furthermore a distinction in regard to the mode of development of these bodies. Thus in the *Algæ* are found the simplest forms of reproductive organs and a direct germination. In the Equisetacean type, in which Herr Schacht includes the ferns, the organs become more complex, and are arranged upon a prothallium; and if the *Lycopodiaceæ* and *Rhizocarpeæ* are conjoined with these families, there is observed the arrangement of the male and female apparatus upon the same surface or expansion. In the Characean type the spermatozoids, though similarly constructed, "make their appearance on the fully-developed plant; no direct germination ensues, but rather the production of a prothallium from a budding, out of which arises the young plant."—Vide abstract of Schacht's memoir in *Microscopical Journal*, No. XVII.

The External form of Sigillaria, according to a statement made at a meeting of the Manchester Philosophical Society, on Feb. 7th, by Mr. Binney, has not been properly understood. The Sigillaria, from clear evidence which he had obtained, was not only the chief plant from which our coral deposits have been formed, but was really a tree which branched like the Lepidodendron, and was not the strange stunted-topped plant which some writers have represented it to be.

Connection between the existing Flora of Australia and the Plants of the Eocene Formation.—In the *Journal of Botany* for February we find a translation of a lecture delivered some time back by Dr. Unger, Professor of Botany in the University of Vienna. In this we perceive some startling resemblances shown to exist between the plants of Australia and those of our European Eocene deposits. Indeed, the similarity is so striking, as demonstrated in the numerous illustrative figures, that it is quite impossible to disagree with the conclusions drawn by the Professor; viz., that during the Eocene period the two continents were connected. Not only do we find, says the lecturer, several fragments of the polymorphous order *Myrtaceæ*, but it is plain that the genus *Eucalyptus* itself is represented amongst the fossils. Of several species the peculiar leaves, as well as the fruit, have been found. The same is the case with the Epacrids, although as yet only a single leaf furnishes evidence of the former existence of this now widely-distributed order. But, much more stress has been laid on the *Proteaceæ*, than the Myrtaceæ and Epacrids, as the characteristic plants of the Eocene period. We have found of them different leaves, fruit, and seed, and are even in a position to make out certain genera such as Banksia, Dryandia, &c. Thus it would appear that the *Proteaceæ*, now constituting the principal part of the scrub vegetation of New Holland, played a similar *rôle* during a former geological epoch of Europe. A deal of similar evidence is advanced by Dr. Unger, whose lecture we commend to our readers' notice.

Testimonial to Dr. Lindley.—From the pages of a contemporary we learn that upwards of 200 names are subscribed to the Lindley testimonial. This enabled the promoters to order a handsome piece of plate, worth about 200 guineas, which borrowed some of the details of its ornamentation from the orchids and other plants to which Dr. Lindley's studies have been specially directed. The delicate attention shown in the design has been duly appreciated by Dr. Lindley, who, prevented by ill-health from receiving the deputation that was to present the testimonial, has gracefully acknowledged his thanks in a letter addressed to Mr. Bateman.—*Journal of Botany*, No. XXVI.

Connection between the Laticiferous and Fibro-Vascular Vessels in Plants.—It may appear strange that such a communication as that inferred by this heading should exist. Yet we think that M. Trécul, who has tried to establish the fact, has been tolerably successful in his efforts. In *Beaumontia grandiflora*, one of the *Apocyneæ*, one frequently finds in the inner bark vertical laticiferous vessels give off lateral branches, which in their turn travel through the medullary rays and thus reach the central pith : arrived here, they then anastomose with the proper latex vessels of this locality. In the *Lobelia* tribe the latex vessels are exceedingly numerous in the inner bark, near the cambium layer ; they form an exquisite network, whose meshes are sometimes long, but at others short and narrow. There are also a number of isolated vessels close to the network, and which communicate with this latter by numerous anastomoses. From the inner reticulation several vessels pass inwards towards the woody bundles, and outwards towards the bark ; the latter series of vessels traverse the bark in every conceivable direction, and occasionally intercommunicate. The branches which travel towards the centre of the stem may pass along the medullary rays ; but in many instances they are in contact with the woody fibres and vessels only. These branches are in some cases in close contiguity. From *Isotoma longiflora* M. Trécul obtained a transverse section, which exhibited no less than *eleven* of these latex vessels in a space measuring about the third of a millimetre. Almost all of them formed anastomoses with the woody tissue.—Vide *Comptes Rendus*, January 9th.

Do the Leaves of Plants exhale Carbonic Oxide ?—This question is answered in the negative by M. Corenwinder, many of whose former researches we have referred to in previous numbers. He contrived a simple apparatus for investigating the nature of the gases exhaled. This consisted of a number of tubes connected with bulbs, and attached at one extremity to an aspirator. The air passed in the first place into one or two bulbs containing caustic potash, which removed any carbonic acid that might have been present. It then was made to traverse slowly a horizontal tube containing pumice-stone and oxide of copper, and which was brought to a dull-red heat. In contact with the oxide of copper, the carbonic oxide, or other combustible gases, became converted into carbonic acid, which was then collected in a bulb filled with concentrated solution of baryta. By this experiment often repeated, M. Corenwinder has assured himself that all the carbonic oxide which passes over the copper and into the bulb, is changed into carbonate of baryta. By the assistance, then, of this apparatus, he has arrived at the following conclusions :—

(1.) That there is no appreciable quantity of carbonic oxide or other combustible gases in the atmosphere.

(2.) That decomposing vegetable matter does not evolve any of these gases.

(3.) That the same may be said of the gases, &c., emitted by flowers with the greatest perfume.

(4.) That the leaves of plants never exhale combustible gas either by night or day, or in light or darkness.

(5.) Finally, that when a plant is submitted to the action of the sun, in the presence of a considerable quantity of carbonic acid, this acid is absorbed with rapidity, but the leaves do not give off the faintest trace of carbonic oxide. These experiments have been made upon the mutilated extremities of plants in the country ; in M. Corenwinder's garden on healthy plants ; in fact, under almost every possible condition. M. Corenwinder's conclusions are of importance from the fact that, though arrived at by a different method of experimentalism from that adopted by Boussingault and Cloez, they fully bear out the views of those observers.—Vide *Comptes Rendus*, LX. No. 3.

The Fecundation of Marsilea has lately been carefully worked out by Dr. Hanstein, in the Berlin *Monatsbericht*. A few hours after the microspores and myaspores have escaped into the surrounding water, in the manner formerly described by the author, and issued from their sporangia, the following changes take place. The small androspores become homogeneous and plastic, and contract all round the margin ; the mass then is divided by planes of segmentation into eight parts, and eventually into thirty-two, the process resembling the segmentation of the animal ovum ; and on the completion of the segmentation a cell-membrane is formed round each mass. In each of these thirty-two cells a spermatozoid is developed, and, in the course of from eighteen to twenty-two hours, the developed daughter cells are set free. Each spermatozoid consists of a corkscrew-like filament, which possesses a rapid whirling motion, and is beset by long cilia. The impregnation of the archegonium, which in the mean time has been developing, then takes place.—Vide *Quarterly Journal of Microscopical Science*, January.

A New British truffle is recorded in the January No. of the *Journal of Botany*, by Mr. W. G. Smith. This makes the number of species ten instead of nine, as previously given by the Rev. M. J. Berkeley. The specimens examined were found in the truffle districts of Somersetshire, where it is not uncommon.

New American Station for the Common Heather.—In *Silliman's Journal*, Professor Asa Gray states that Professor Lawson, of Dalhousie College, Halifax, has had the good fortune to bring to light a new locality for the *Calluna vulgaris*, from the island of Cape Breton. The flowering specimen which Professor Lawson sent was collected on the 30th of August last, in a wet springy place among spruce stumps, in peaty soil, overlying clay, on the farm of Mr. Robertson, St. Ann's, Inverness County. He states that it has been known there for ten years, having been noticed by a Highlander when mowing. Full inquiry into the whole circumstance has led Professor Gray to the belief that *calluna* has not been planted at St. Ann's, but is a genuine native. Its surroundings are most appropriate. Both in scenery and vegetation there is a striking resemblance to the Scotch Highlands. Gælic is the common language, and all the genuine manners and customs of the Highlanders. We really think that Professor Gray's enthusiasm has led him a little too far; surely the fact that the Scotch have settled in any locality is no reason why heather should spring up there. The Irish emigrants often take the hazel and shamrock with them from their native shores. May not the Highlanders have a similar predilection for the heather?

CHEMISTRY.

The Preparation of Cyanide of Phosphorus.—Herr Wehrhane thus describes the method adopted by him to prepare this substance. A mixture of cyanide of silver and chloride of phosphorus is heated in a sealed tube. The mixture must be made in a strong tube, which is kept well cooled; the addition of a small quantity of either chloroform or ether helping to delay the reaction. After being sealed, the tube is heated to 130° or 140° for six or eight hours, and the contents are then distilled through a stream of carbonic acid. Long needles and thick tabular crystals of cyanide of phosphorus condense in the neck, and having been allowed to cool, may be readily removed with a glass rod. The crystals inflame when touched with a warm glass rod. In moist air they decompose, giving rise to phosphorus, and phosphorous and cyanic acids. They are sparingly soluble in ether, chloroform, sulphide of carbon, and chloride of phosphorus, and are readily decomposed by water into the same compounds as those into which they are resolved in a moist atmosphere.—Vide notice of *Annalen der Chemie* for December, in *Chemical News*, No. 274.

Oxidation of India-rubber.—At a meeting of the Chemical Society (Feb. 16), Mr. J. Spiller pointed out some facts he had observed in relation to the action of the atmosphere upon india-rubber. It is generally thought that this substance will resist the action of the air almost entirely. Mr. Spiller's examination proved that the india-rubber employed in a manufactured material known as "Patent Waterproof Felt," is liable to alteration as the result of oxidizing processes. This felt is employed in the exportation of silk and other valuable fabrics, which would be much injured by exposure to damp. It appears to be prepared by cementing together the fibres of cotton-wool by means of india-rubber paste, so that when the naphtha which holds the gum in solution has evaporated, a thin layer of solid india-rubber is left behind. Some of this material which Mr. Spiller had purchased years ago, and which had been laid aside, was found to have undergone a change of physical properties; and this circumstance led him to compare its chemical qualities with those of fresh india-rubber. In order to do this, he submitted specimens of freshly prepared and altered felts to the action of warm benzol, and the solution thus obtained was evaporated. In both cases a film was produced; but while in the case of the fresh article the film was one of pure india-rubber, which left the wool unstained from which it had been removed; in the second case it contained other matters, and left the wool stained and discoloured. The residue after evaporation was found to contain a peculiar resinous matter not unlike shell-lac. The properties of this new compound, which was prepared by Mr. Spiller in sufficiently large quantities for chemical examination, were as follows :—Freely soluble in alcohol, chloroform, wood-spirit, and benzol ; inappreciably soluble in ether, bisulphide of carbon, and oil of turpentine ; readily soluble in alkalis, being precipitated from these solutions by acids ; is bleached by exposure to ammonia-water ; fuses below 212° Fahrenheit, and when strongly heated gives off a yellowish empyreumatic oil and water,—the latter demonstrating the presence of oxygen (?) ; brittle and electric at ordinary temperatures, and has, according to analysis, this composition :—

Carbon	64·00
Hydrogen	8·46
Oxygen...	27·54

Gases produced in the Cementation of Iron.—Some very interesting facts relative to the nature of the gases developed during the processes of cementation have quite recently been indicated in a memoir presented by M. Cailletet to the French Academy. The experiments of this investigation were carried out at the great factory of Drambon, by permission of MM. Guenard and Co. In order to collect the gases for examination, a hole was bored into one of the cases in which the iron is packed before it is submitted to heat, and into this aperture was fitted a porcelain tube. One of the extremities of this tube was plunged for a depth of 40 centimetres into the case, and to the outer end was attached a tube of glass. By means of this apparatus the gases were made to traverse a series of bulbs, and were finally collected in an aspirator specially arranged. After the fires had been burning for five hours, the aspirator was put in action, and the collected gases were analyzed by the simple method devised by M. Peligot. The following figures, which represent the mean of two analyses, were the results obtained :—

Carbonic acid	20·06
Carbonic oxide	15·55
Hydrogen	26·60
Nitrogen	37·79
	100·00

In a second inquiry, when the gases were collected sixty hours after the furnaces had been lit, the results were very different ; thus, omitting fractions, the nitrogen was in the proportion of 46 per cent., the hydrogen of 38, the carbonic oxide of 16 ; whilst there was not a trace of carbonic acid present. In every case the gases were washed prior to their examination, but the water gave not the faintest trace of cyanides.—Vide *Comptes Rendus*, Feb. 13.

Removal of Sulphide of Carbon from Coal-gas.—Bisulphide of carbon has long been the bugbear of gas manufacturers, and it is therefore satisfactory to be able to record the discovery of a process for the purification of gas by the removal of this substance. Sulphide of carbon is a liquid and easily volatilized compound, of one equivalent of carbon and two of sulphur, and in combustion it is resolved into carbonic and sulphurous acids. Now, sulphurous acid, besides being a vapour possessing the unpleasant smell of burning sulphur, has also other qualities of a highly detrimental character

Thus it is poisonous to animal life when inhaled in any considerable quantity, and it destroys almost all vegetable colours, by depriving them of their oxygen. Heretofore the methods adopted for the removal of this compound from coal-gas were inadequate, and the result was that all—even the purest—forms of gas contained this impurity in greater or lesser proportions. The new method has been devised by Mr. Lewis Thomson, a gentleman already well known for the importance of his gas researches. Briefly, his process is as follows :—After the gas has left the hydraulic main, and before it reaches the condenser, it is mixed with a suitable quantity of steam (superheated or not), and the mixture is passed through a retort or tube heated to 1200 Fahr. The shape of the retort is not of much importance, but it appears that the elliptical form possesses advantages over the cylindrical, and that a cast-iron vessel is better than a clay one. The length of the tube (or retort) must be proportioned to the velocity of the current passing through it. When the two vapours—bisulphide of carbon and steam—are allowed to react upon each other in this way, mutual decomposition is effected ; the carbon of the sulphide abstracts oxygen, and becomes converted into carbonic acid, while the sulphur and hydrogen unite to form sulphuretted hydrogen, which can afterwards be removed. The decomposition is thus represented :—

$$\underbrace{CS_2}_{\substack{\text{Sulphide of}\\ \text{Carbon.}}} \quad + \quad \underbrace{2HO}_{\text{Water.}} \quad = \quad \underbrace{CO_2}_{\substack{\text{Carbonic}\\ \text{acid.}}} \quad + \quad \underset{\substack{\text{Sulphuretted}\\ \text{Hydrogen.}}}{2HS}$$

Vide *Newton's Journal of Arts and Sciences*, February.

New Mordant for Aniline Dyes.—It is reported that this long-wished-for substance has at last been discovered. It consists of acetate of alumina and arseniate of soda ; and its discoverer, Herr Schultz, believes that it will eventually replace albumen, gluten, tannin, and the various other substances now employed for a similar purpose. To prepare the mordant, Herr Schultz mixes, at an ordinary temperature, four grammes of ordinary aniline violet in powder, with a quarter of a litre of acetate of alumina and twenty grammes of arseniate of soda, which he thickens with starch boiled in water. In the case of prints it is recommended to mix the arseniate of soda and acetate of alumina with the colouring matter, and to steam the fabric over the mixture. For dyeing, it is said to be better to treat the tissue in the first place with a mixture of the two salts, and afterwards to dip it in the colour-vat in the usual way.—Vide *The Artizan*, January.

Danger in Preparing Oxygen.—Those who are in the habit of preparing oxygen on a large scale—as, for example, for oxyhydrogen lamp purposes—will do well to examine the mixture which is sold in commerce as chlorate of potash and black oxide of manganese. A very serious accident occurred lately from the employment of an adulterated specimen of this powder, in which charcoal had been partially substituted for binoxide of manganese. By combining (mechanically) charcoal with chlorate of potash, a substance having much the appearance of the genuine article is produced ; but this mixture is as dangerously explosive as gunpowder, and a few months ago caused the death of two individuals (Mr. Crowther, of Manchester, and his son) who were engaged in the preparation of oxygen gas.

The Deposition of Metals by a new process has been discovered by M. Well, a French chemist. The baths he employs consist of metallic salts or oxides, in alkaline solutions, by means of glycerine, albumen, and other substances, which prevent the precipitation of the oxide by the fixed alkali, in some cases with, and in others without, the aid of zinc or lead, and at various temperatures, according to circumstances. The discoverer asserts too, that by these means, in covering other metals with copper, he can produce any variety of colour that may be desired. The most important applications of the discovery are the deposition of copper and the bronzing of iron and steel without the preparatory dressings with conducting substances, which are necessary when the deposit is produced by means of galvanic agency. M. Well considers that by his process iron and steel may be first coated with copper, and afterwards covered with a stratum of silver or nickel.

Aniline Black, which is a new member of the aniline series, differs in many particulars from all other black colouring materials. It is easily fixed, has a powerful attraction for fabrics, and does not appear to be affected by either physical or chemical agencies. Mr. Lightfoot's process for the preparation of this dye has been already described. A new method, however, has been announced by M. Lauth. This, which is a modification of Mr. Lightfoot's invention, consists in printing with a sulphide of copper in addition to the hydrochlorate of aniline and chlorate of potassium. Sulphide of copper, though an insoluble salt, becomes oxidized, and soluble on the fabric. By the oxidizing action of the chlorate the sulphide becomes sulphate, and by the action of this the desired result is obtained.—Vide *Moniteur Scientifique*, January, 1865.

GEOLOGY AND PALÆONTOLOGY.

Distribution of the Laurentian Rocks.—This subject is discussed by Sir Roderick Murchison in a paper, in which he shows that the relation now believed to exist between certain beds in Scotland and Ireland and the Laurentian system as it is developed in Canada, was pointed out by him years ago. The British rocks which he has shown to be of Laurentian age occupy striking headlands in Sutherland and Ross, where they are unconformably surmounted by both Cambrian and lower Silurian rocks. At first he gave them the name of "Fundamental Gneiss." They were then described as being completely dissevered from all the palæozoic rocks, not only by unconformability, but also by having a peculiar divergent strike from S.E. to N.W., being at right angles to that of all the superjacent deposits of Britain. It appears that, although Sir Roderick fancied the system described by him was related to the Laurentian, he was unaware of the identity of the two till he called the attention of Professor Ramsay to the striking features of the "Fundamental Gneiss." The Professor, however, who had explored the Canadian rocks in company with Sir W. Logan, at once declared Sir Roderick's new system to be genuine Laurentian. Attention is now called to the matter by the author of "Siluria" because of the circumstance that Sir Charles Lyell, in the edition of his "Elements" just published, does not allude to Sir Roderick Murchison's discovery, but dismisses the subject of Laurentian rocks in the following words:—"The oldest stratified rock in Scotland is that called by Sir R. Murchison 'the Fundamental Gneiss,' which forms the whole of the island of Lewis in the Hebrides. On this gneiss, in parts of the Western Highlands, the Lower Cambrian and various metamorphic rocks rest unconformably. *It is conjectured that this ancient gneiss of Scotland may correspond in date with part of the great Laurentian group of North America.*"—Vide *Geological Magazine*, March.

Man co-existent with the Reindeer and Beaver.—Professor Van Beneden, who lately explored the bone caverns of Nutons, in the valley of the Lesse, gives the following description of the fossils found in this grotto :—The bones of the skeletons were found scattered ; the long bones were placed longitudinally, and in one instance a cranium was found covered by an enormous stone, which was adherent to the walls of the cavern by stalagmite. This cranium was half-filled with stones, which appeared scarcely smaller than the occipital foramen through which they must have passed. In front of the cranium were found a scapula, some clavicles, ribs, long bones, and vertebræ of youths, children, and adults. One of the neck vertebræ had been pressed with such violence against the coracoid process of the scapula that the ring was broken, and the two structures could not be separated without violence. In other instances bones were found wedged in between stones in such a manner that there was no space left between the two materials. Human bones occurred side by side with those of a bear allied to *Ursus spelæus*, and of the ox, horse, reindeer, beaver, goat, glutton, some carnivora, birds, and fish. With the animal remains there occurred specimens of flint implements of a rude kind, some pieces of coarse pottery, fragments of charcoal, calcined bones, and some antlers of the reindeer, which bore evidence of a primitive carving or ornamentation. In making the investigations it was found that there was no disturbance of the soil, and that the only external communication was in front.—Vide *Comptes Rendus*, t. LIX., No. 26.

The Eruption of Etna, which is reputed to continue its work of devastation, is stated by M. Elie de Beaumont to have taken place at a point about as distant from the centre of the mountain, and as high above the sea-level, as the spot near Nicolosi where the celebrated eruption of 1669 occurred.

A Jawbone of the Red Deer (*Cervus Elaphus*) was discovered by the workmen engaged in sinking one of the cylinders for the new sea-forts at Spithead, and has been forwarded by Mr. T. Harris to the British Museum. The specimen consists of the left ramus of the lower jaw, and has five teeth *in situ*, the crowns of which are all worn ; showing it to have belonged to an adult animal. In the inner sides of the teeth and jaw were found patches of a thin incrustation of iron pyrites. The bone was extremely fresh-looking, and, though found at a depth of 40 feet in the shingle, must have been deposited at a comparatively recent period.

The Gibraltar Cave-fossils.—Mr. Busk's long-expected paper upon this subject was read before the Ethnological Society on Tuesday, February 7th. The rock in which the caverns of Gibraltar were found is limestone, and extends for about three miles from north to south, at an elevation varying from 1,400 to 1,200 feet. It is geologically divided into three nearly equal portions by cleavages, which separate the higher parts of the rock on the north and south from the central and lower part. At the southern face of the rock there is comparatively low ground, the Windmill Hill being about 400 feet above the level of the sea; but the strata there are inclined in an opposite direction to the great mass of what is termed the "Rock of Gibraltar." In the Windmill Rock the caverns have been found, and in these latter a great quantity of bones was discovered. The bones, which were mingled with pottery, flint implements, and charcoal, appear to have been deposited at different periods, and were found at various depths, the lowest being 14 feet below the floor of the cavern. Those in the lowest layer consisted of the bones of mammals, several of which were of extinct species. They were imbedded in ferruginous earth partially fossilized, and were covered with stalagmite—no human bones were with them. Above this layer were deposited the remains of about thirty human skeletons, with fragments of pottery, flint implements, particles of charcoal, and a bronze fishing-hook. Some of the pottery had been turned in a lathe, and bore evidence of classic art. In another cavern, discovered under the foundation of the military prison, the remains of two isolated skeletons were also found. Only one skull had been discovered there, and that had been sent to Mr. Busk, who remarked that the lower jaw transmitted with the cranium did not belong to it, showing that there must have been another skull in the cavern, though no trace of it had been found. There was nothing in the form of the skull to distinguish it from the ordinary European type; but the bones of the leg were remarkably compressed; for which appearance it was difficult to account. Since Mr. Busk's attention had been drawn to this character, he had observed a similar compression in the leg-bones of other human skeletons, which were known to be of great antiquity. Whether this conformation was to be regarded as a race-character, or was produced by special occupation or habit, Mr. Busk would not venture an opinion upon; but Professor Huxley, who was present, considered the compression to indicate a race-character that had originally been induced by either habit or disease, and he regarded the perpetuity of the character as a confirmation of the Darwinian theory.

Pre-historic Pile-houses.—At a meeting of the French Academy in December, M. Leroq presented a memoir on the inabitants of pile-houses and caves. In Venetia he states that he has found the remains of those tribes who peopled Europe before the immigration Aryas. In the cavern of Lusingnano, at a level of ten feet below the surface, he found flint implements resembling those discovered at Perigord, fragments of pottery, and a bone needle. In an adjacent cavern he found associated with the flint implements, teeth, jaws, and other bones of the great fossil bear: the specimens discovered were, unfortunately, in a very mutilated condition.

Iron Implements in Crannoges.—In a letter addressed to the *Reader*, by Mr. George Henry Kinahan, some important points relative to the antiquity of iron, and the necessity for seeking for *traces* of this metal, have been dwelt on. While investigating one of the largest Crannoges or artificial islands in Lough Rea, co. Galway, he found only stone implements, with the exception of a rude knife, which appeared to be of some sort of bronze. But he observed facts which would seem to indicate that iron implements had been in use among the inhabitants of the Crannoges. These facts are as follows:—1st. All the stakes that were drawn had been pointed by a sharp cutting instrument, as was evidenced by the clean cuts. 2nd. Pieces of deer's horn that were found had been divided by a very fine saw, as was proved by the absence of marks of graining on the surface of the sections. 3rd. On some of the bones there were furrows, evidently made by sharpening fish-hooks or some pointed implement on them. 4th. In various places *nests of peroxide of iron* were observed, as if an iron instrument had once been there, but had been corroded away in course of time. Mr. Kinahan draws particular attention to the circumstance that "few metals corrode as fast as iron, and that, while stone and bronze would last for ages, iron would disappear, owing to corrosion, in a comparatively short space of time."

Eozoon in Britain.—The fossil Rhizopod, which has lately attracted so much attention in these countries and abroad, is, it appears, not confined to the Canadian rocks. Mr. W. A. Sandford has discovered Eozoon in the green marble rocks of Connemara, in Ireland. His assertion that it is to be found in these deposits at first excited very grave doubts as to the accuracy of his observations. Since his first announcement of the discovery, his specimens have been examined by the distinguished co-editor of the *Geological Magazine* (Mr. H. Woodward), and this gentleman fully confirms Mr. Sandford's opinion. In the specimens prepared from Connemara marble, "the various-formed chambers—the shell of varying thickness—either very thin, and traversed by fine tubuli, the silicate filling which resembles white velvet-pile, or thick, and traversed by brush-like threads, are both present. Although the specimens were not so carefully prepared as those mounted for Dr. Carpenter, still the structure was so plainly perceptible as to render the diagnosis incontrovertible.

A new "Coal" Reptile.—Professor Owen has described a fossil from the coal-beds of Glamorganshire, and given it the name of *Anthrakerpeton crassosteum.* The bones examined were those of a batrachian vertebrate resembling the saurians in some respects. He supposes it to have belonged to that "low, probably primitive, air-breathing type which, with developmental conditions of the bones like those in some fishes, and very common in Devonian fishes, showed forms of the skeleton more resembling those in saurian reptiles than are attained by any of the more specialized batrachian air-breathers of the present day." The specific name refers to the density and thickness of the long bones which the Professor examined.—Vide *The Geological Magazine*, January.

MECHANICAL SCIENCE.

Small-wheeled Locomotives.—Mr. Zerah Colburn has published a paper advocating the return to smaller driving-wheels in fast passenger engines, in accordance with American and Continental practice. With a given train, resistance at a given speed, the smaller the driving-wheel the shorter must be the stroke and the greater the piston speed. The earlier locomotive engineers imagined that a mean piston speed of 500 feet per minute should not be exceeded, and built their engines accordingly; but the exigencies of more recent practice have compelled the adoption of a speed of 1,000 feet per minute, or more, without ill effect; and even this speed may, in Mr. Colburn's opinion, be exceeded with safety. By adopting a high piston speed and small driving-wheels, the following advantages are gained:—1st. The centre of gravity of the engine is lowered; 2nd. The strain on the moving parts is reduced, and these parts may be lightened; 3rd. The upward pressure of the crossheads on the motion-bars is reduced, and the tendency to "rolling" diminished; 4th. The strain on the cylinder fastenings is reduced; 5th. Engines with small driving-wheels pick up their speed sooner than others; 6th. The blast, from the greater frequency of the strokes, would act more effectually, and hence a smaller boiler would suffice to raise the steam; 7th. A less proportion of the weight would be unsupported by springs, and hence the wear and tear of tyres and rails would be reduced.

Competitive Trial of Rifled Guns.—The following table gives the particulars of the guns to be experimented upon by the Ordnance Select Committee:—

System.	Characteristic.	Calibre.	Weight.	Length of Bore.	Weight of Shot.
		Inches.	Cwt.	Inches.	lb.
Lancaster	Oval bore	7	149	126	110
Commander Scott	Long bearings	7	149	126	110
French	Zinc studs	7	149	126	110
Jeffrey-Britten	Expanding projectile	7	149	126	110

The mean ranges attained in the trials already made have been from 1,361 to 1,604 yards, with 2° elevation, and from 4,543 to 4,779 yards with 10° elevation, the charge being 25 lb. of powder. The Jeffrey-Britten gun has been withdrawn from trial, the lead on the base of the shot proving too weak to withstand the charge. The Scott gun appears thus far to have given the best results. Captain Blakely's 7-inch gun is also under trial. It is stated that recently at Shoeburyness 100 rounds were fired from a gun at the rate of seven and a half rounds per minute.

New Prime Mover.—M. Ch. Tellier has proposed ammoniacal gas as a substitute in certain cases for steam. Its advantages are stated to be its great solubility in water, its easy liquefaction, its capability of supplying motive power at the ordinary atmospheric temperature, and of being superheated without too great an increase of temperature, the possibility of re-collecting it by solution, and the facility of extracting the latent heat from the vapour after the latter has been employed, and transmitting it to that which is about to be used, by the simple act of dissolving in water.

Thin Plates of Steel and Iron.—Various firms have lately produced iron plates of extreme tenuity by rolling, the thinnest being those obtained by Messrs. R. Williams & Co., of West Bromwich. These were 69 square inches in area, and weighed only 49 grains, corresponding with about $\frac{1}{2000}$ inch in thickness. Messrs. Gillott have also rolled steel plates $\frac{1}{1800}$ inch in thickness. This is thinner than the thinnest tissue-paper.

Pneumatic Loom.—Mr. Harrison has introduced a most important improvement in the power-loom. It has long been known that the picking motion which drives the shuttle through the shed is one of the least satisfactory parts of the loom. It is cumbrous, heavy, liable to get out of order, and entails vibration in all parts of the mechanism. Mr. Harrison substitutes for the indirect mechanical blow the action of compressed air. At each end of the lathe the shuttle is received within a small square box or tube, which it fits loosely. The end of this tube communicates with a valve-chest by an aperture covered by a puppet valve kept closed by the pressure of the air. A species of trigger gear, similar to that employed in an air-gun, raises the valve from its seat for an instant at every alternate stroke of the lathe, and the small quantity of air thus admitted blows the shuttle through the shed. The air is compressed to about 30 lb. per square inch, and is brought to the loom in pipes beneath the floor. The results thus far obtained have been in the highest degree satisfactory.

Fluid Bearings.—We once before alluded to the fluid bearings of M. L. D. Girard. He has now communicated to the Academy of Sciences the results of some experiments on the bearings of the fly-wheel shaft of a rolling machine. The fly-wheel weighed 34 tons. With the bearing surfaces greased only, the coefficient of friction was found to be 0·1. With water forced in between the bearing and axle, so as to escape across the whole bearing surface, the coefficient was reduced to 0·001, and in ordinary circumstances did not rise above 0·003. The water was forced in under a pressure of ten atmospheres.

Magnetic Driving-wheels.—Sir Charles Fox has made an ingenious suggestion to apply electricity to increase the adhesion of the driving-wheels of locomotives, which at times (especially in some states of the weather) is so much reduced that the utmost difficulty is experienced in the propulsion of heavy trains. Sir Charles Fox proposes to surround the lower part of the driving-wheel with a coil of insulated wire, so that when a current of electricity is passed round it from a quantitative battery placed on the engine, the wheel becomes a temporary magnet acting on the rails.

Mont Cenis Railway.—Pending the completion of the great Mont Cenis tunnel, a temporary railway on inclined planes is to be carried along the present road over the mountain. The French Government, on its portion of the line, will use locomotives with a peculiar mechanism, to produce adhesion, on a middle rail placed between the two ordinary rails. On the Italian side a traction carriage will be employed, which will wind the carriages up by means of a drum acting on a heavy fixed cable laid along the line. The mechanism of the traction waggon will be put in motion by an endless wire rope actuated by water-wheels at the base of the incline.

MEDICAL SCIENCES.

Preservation of the Dead.—A very curious process for the preservation of dead bodies has been discovered by Signor Gorini, which, if easily carried out, will prove of much service to teachers of anatomy. The following extract from a letter of Signor Matteucci to the French Academy, although it does not explain the mode of preparation, gives ample evidence as to its results:— The bodies prepared by Gorini's process preserve for some months the natural consistence and plumpness, and have no more smell than that which they possessed prior to preparation. In this condition they may always be employed for dissection. After a time, instead of putrefying, they simply become dried up, and, as it were, mummified; but even when in this state they can easily be restored to their former appearance, by being left for some time in a water-bath. The viscera, blood-vessels, muscles, and nerves remain perfect, and the latter may be traced to their ultimate extremities. After restoration, the bodies are again liable to desiccation on exposure to air; but they may, a second time (or even oftener), be restored by immersion in water.

The Electricity of Mineral Waters has been treated of in a paper in the *Comptes Rendus* for February, by M. A. Lambron. He considers that in all sulphur waters there are two strata of electricity. The upper portions of the liquid present an excess of *positive*, and the lower ones of *negative* electric fluid. Consequently, when we take a sulphur bath, the lower regions of the body are charged *negatively*, and the upper *positively*. The writer considers that these statements are proved by experiment, and lays considerable stress upon what he is pleased to term the importance of the subject which he has taken up for investigation.

Terminations of the Nerves.—It may now be nearly regarded as proven that the nerve-fibres do not terminate in the parts to which they are distributed; but, after travelling from some particular centre to an extremity, then take a backward course, and finally arrive at the point from which they started. Admitting this view, we have then another fact in support of the hypothesis that nerve-force, as it is called, is nothing more than electricity acting under peculiar conditions. Dr. Beale, although he by no means claims for this doctrine a universal assent, still conceives it to be at least probable. In speaking of the two sets of cells, caudate and rounded, which are connected with the nervous filaments, he attributes to the latter the power of originating currents, while the other he fancies is concerned more particularly with the distribution of these and of secondary currents induced by them, in very many different directions. A current originating in a *ganglion cell* would possibly give rise to several induced currents as it traversed a *caudate nerve-cell.* It seems probable that nerve currents emanating from the round ganglion-cells, may be constantly traversing innumerable circuits in every part of the nervous system, and that nervous actions are due to a disturbance, perhaps a variation in the intensity of the currents, which must immediately result from the slightest change occurring in any part of the nerve-fibre, as well as from any physical or chemical alteration taking place in the nerve-centres, or in any of the peripheral nervous organs.—Vide *The Quarterly Journal of Microscopical Science,* No. XVII.

The Oral Mucus in Typhoid Fevers.—M. A. Netter has drawn attention to some important observations which he has made in regard to the mouths of patients suffering from typhoid fevers. It appears, from this *savant's* investigation, that in fevers of a zymotic kind the interior of the mouth is subject to peculiar alterations, which have not received the consideration they deserve. A peculiar blackish fœtid matter is secreted by the mucous membrane, and forms a suitable nidus for numerous parasites. The air which the patient inhales becomes impure in passing over the unhealthy membrane, and being in this condition introduced into the lungs, it slowly poisons the system. Such being the case, M. Netter suggests the employment of *acid gargles,* which, according to the results of his experience, are always attended with favourable consequences. The gargles should be constantly repeated.—Vide *Comptes Rendus,* December, 1864.

Consanguineous Marriages.—M. A. Voisin has put forward some interesting facts tending to prove that marriages of consanguinity are not productive of the evil consequences usually attributed to them. He carried on his inquiries in the town of Batz, in the Loire-Inférieure. Having selected forty-six cases of consanguineous marriage, he examined the husbands, wives, and children in regard to their physical and intellectual development, and made inquiries concerning the families examined and their ancestors, through the assistance of the mayor, pastor, and oldest inhabitants. Combining the statistics thus collected, he finds that intermarriages do not bring about disease, idiocy, or malformation. The town of Batz is situated upon a peninsula, bounded on one side by the seashore, and on the other by salt marshes. The air is pure, and the most frequent winds are those from the north, north-east, and north-west. The number of inhabitants is about 3,300. They have little communication with other parts of the country, and their occupation is almost entirely confined to the preparation of salt. They are very intelligent, almost all the adults being able to read, and the morality is of the highest stamp. Theft or murder has not occurred within the memory of the oldest inhabitant. The mothers nurse their children till they are fifteen months old, and the general food of the population is of the vegetable class. There are at present, in Batz, forty-six couples who are cousins—five who are second cousins, thirty-one who are third cousins, and ten who are fourth cousins. From the five unions of second cousins there have been produced twenty-three children, none of whom have presented any congenital deformity. The thirty-one marriages of third cousins have produced a hundred and twenty children, all healthy; and the marriages of fourth cousins have given rise to twenty-nine children, all of whom, with the exception of a few attacked by ague, were strong and healthy at the time of examination. The writer contends that such facts as the foregoing prove that consanguineous marriages by no means lead to the degeneration of a race.—Vide *Comptes Rendus*, January 16th.

Spores of Achorion in the Air.—The experiments of M. Bazin demonstrate that the atmosphere surrounding persons affected with favus contains the spores of *Achorion Schoenbeinii.* He selected a patient, aged sixteen, who had suffered from favus for seven years, affecting the whole of the hairy scalp, and placed him under such circumstances, that a current of air passing over his head was directed against two jars filled with ice, and placed in a basin at a distance of fifty centimetres. By making the patient rub his head and hair, the current of air carried to a distance particles of favus crust, visible to the naked eye, in which the microscope discovered the existence of the achorion. But as the current of air passed over the vessels of ice, it deposited its moisture, and this running down the sides of the basin, was collected in the basin below. In the fluid a great number of isolated spores were found. The experiment was repeated several times, and on each occasion thirty or more spores were demonstrated in a single drop of the liquid. The experimenter concludes that the spores may be carried by atmospheric air, and that what was formerly only an hypothesis is now a demonstrated fact.—Vide *Gazette Médicale*, and *Medico-Chirurgical Review*, No. LXIX.

The Nerves of the Intestines.—In "Virchow's Archives" (1864, p. 457), Auerbach gives the results of his examination of the histology of the intestines. The chief plexiform layer of nervous tissue in the intestinal wall is always situated between the circular and longitudinal layers of muscle, and the fibres of which it is composed have generally a circular disposition. They are found throughout the whole of the intestine, and contain numerous ganglia. In the higher animals the development is considerably greater than in the lower; and the larger the animal, the coarser are the fibres, and the wider are the meshes of the network. The nervous plexus of the intestine is intimately connected, on the one hand, with the great centres of the nervous system, through the mesenteric nerves; and on the other hand with the pneumogastric nerves through its communication with the gastric nervous plexus. It is also connected with the nervous layer, lying beneath the mucous layer of the intestine. The connection with the mesenteric nerves is accomplished through a plexus which lies beneath the serous layer of the intestine. The histological constituents of the plexus mesentericus are fine primitive nerve-fibres, ganglion-cells, and connective tissue. The fibres are grouped in bundles of from two to four, or four to eight, surrounded by a delicate nucleated sheath.—Vide *Medico-Chirurgical Review*, January.

Cause and Cure of Cataract.—Sir David Brewster, to whom we owe so much for his researches upon the structure of the crystalline lens, lately read a paper before the Royal Society of Edinburgh upon the above subjects. Having himself, about forty years ago, experienced a slight attack of cataract, he was led to make a number of investigations into the structure of the crystalline lenses of various animals. From these researches he concluded that the cause of the disease was simply an insufficient supply of the proper fluid of the lens (liquor *Morgagni*), and hence the separation of the various laminæ which compose this body. The cure was effected in eight months, by copious and continued doses of "compound saline powder." Sir David imagined that the supply of fluid to the crystalline lens might be derived from the vitreous humour, and that the cataract might result from too large a percentage of albumen in that secretion. The cure might then be effected either by injecting distilled water into the aqueous humour, or by tapping the aqueous chamber, in the hope that the newly-formed secretion would contain less albumen than the pre-existing one. The cure of soft cataract, on the other hand, might be effected by the introduction of additional albumen into the aqueous chamber. Sir David has called attention to these views, because, though originally put forward many years ago, they have since been fully confirmed by ophthalmic surgeons.

The Function of the Spleen, according to M. Ester's newly-announced views, is connected with the amount of oxygen present in the gastric blood. From several experiments, he finds that during active digestion, the blood of the splenic vein contains only half as much oxygen as when the stomach has been for some time empty.

METALLURGY, MINERALOGY, AND MINING.

Coal-mining Machinery.—An improved apparatus for getting coal has been described by Mr. W. W. Burdon. He proposes to employ a hammer or piston, driven by steam or air, to work upon a pick by blows on the head, while the pick is held loose by a man, or is attached to the piston so as to loosen the coal at the top, bottom, or sides, by elevating or lowering the frame on which it stands. A circular saw is also attached to the machine.

Rocks yielding Petroleum.—In a paper upon this subject, which was published in the *Scientific American*, the following conclusions relative to the proper method of working the petroleum rocks are stated :—

(1.) Each widely-separated locality must be governed by its own laws, as developed by boring and observation.

(2.) Each geological horizon of oil-bearing rock, receives its supply not from another, but from causes operating at the time of its deposition (!).

(3.) There is not now any reproduction of oil, but we are drawing from fountains filled "of old."

(4.) No strata are so thoroughly saturated with oil as to form a subterranean sheet of rocks where petroleum is sure to be found. The oil occurs in frequent isolated fissures, at various depths, and of various sizes, and containing different grades of oil.

A thin Plate of Iron.—A curious specimen of rolled iron was some time ago transmitted to the *Birmingham Journal.* It consisted of an extremely thin sheet of the metal, which had been used instead of paper as a medium of correspondence. The writer, dating from South Pittsburg, says, "In the number of your paper dated October 1st there is an article setting forth that John Brown & Co., of Sheffield, had succeeded in rolling a plate of iron 13½ inches thick. I believe that to be the thickest plate ever rolled. I send you this specimen, prepared at the Sligo Works, Pittsburg, as the thinnest iron ever rolled in the world up to this time."

The iron sent appears to be of exceedingly fine quality, and the sheet is by far the thinnest ever seen in this country. Tested by one of Holtzapffel's gauges, the thickness of the sheet was found to be the *one thousandth of an inch!* A sheet of Belgian iron, supposed hitherto to be the thinnest yet rolled, is the six hundred and sixty-sixth part of an inch thick ; and the thickness of an ordinary sheet of note-paper is about the 400th of an inch.—Vide *The Artizan*, January.

The Conversion of Iron into Steel.—The many complex questions relating to this process having lately engaged the attention of many members of the French Academy, M. Caron was induced to make a series of experiments, the results of which he has reported. A bar of iron one centimetre square, and thirty centimetres long, was heated in a long earthen tube filled with graphite, broken into pieces about a cubic centimetre in size. The extremities, which had been imperfectly plugged with two pieces of graphite, allowed the air to enter the tube, while the latter, itself being porous, was traversed by the gases of the furnace. The entire apparatus was exposed to a cherry-red heat for six hours, at the end of which time the bar was drawn from the tube and hammered and tempered preparatory to its examination. The metal was fibrous ; it could hardly be bent when cold, without being completely shattered ; its surface was easily acted on by the file ; in fact it gave no trace of having become steel. Other experiments gave like results. From these M. Caron concludes that graphite is not the only carbon incapable of converting iron into steel. Lamp-black, probably coke, and all carbons deprived of alkalies and carburetted gases, will give the same results.

Petroleum in Canada.—It would appear from the recent statements in an American periodical, that Professor Silliman examined part of California in the summer, and found oil, equal in quality to the best in Pennsylvania, struggling to the surface of the earth, and running to waste for miles. In some places it has entirely prevented the progress of agricultural operations.

The Mont Cenis Tunnel.—In a late number of the *Revue Contemporaine* some interesting details concerning the apparatus employed in boring through the Alps are given. The machine consists of a piston working horizontally in a cylinder, and carrying a chisel fixed upon it like a bayonet, which at each stroke dashes with violence against the rock to be pierced. Each time the chisel recoils it turns round in the hole, and as the latter is sunk deeper and deeper, the frame-shield, which carries not one, but nine perforators, advances in proportion. While the chisel is doing its work with extraordinary rapidity, a copper tube of small diameter keeps squirting water into the hole, by which means all the rubbish is washed out. Behind the shield there is a tender, which, by the aid of a pump set in motion by compressed air, feeds all these tubes with water. The noise caused by the simultaneous striking of all the chisels against the rock is absolutely deafening, enhanced as it is by the echo of the tunnel. All at once the noise ceases, the shield recedes, and the tunnel is perceived riddled with holes varying in depth from eighty to ninety centimetres. These holes are now charged with cartridges, slow matches are inserted, and the workmen retire in haste. The explosion seems to shake the mountain to its foundation; and when all is over the ground is covered with fragments of rock, and an advance equal to the depth of the holes has been obtained.

What are Alloys?—A curious paper, entitled "New Facts relating to Cast Iron and Steel," appears in the *Comptes Rendus*, from the pen of M. Jullien. The writer concludes that metals do not combine with each other; that iron does not unite with either carbon, silicon, or nitrogen; and that a mixture of hydrate of lime and dry hydrated sulphate of soda presents all the characters of a solution, but none of those of combination. Some of M. Jullien's views, though put forward as original, have a strange resemblance to those long since announced by Dr. Matthieson, F.R.S., in his important memoirs upon the nature of alloys. Liquid cast-iron, he says, is a solution of liquid carbon in liquid iron; soft steel is a solution of amorphous carbon in either amorphous or crystalline iron. Grey pig-iron, obtained by casting in hot moulds or sand, is a mixture of graphite and steel, the components, iron and carbon, being both in the amorphous condition. Graphite, being amorphous, according to M. Jullien, carbon cannot crystallize without becoming diamond; the supposed crystals of graphite are really casts of other crystals. Some of M. Jullien's other conclusions are equally startling. For example:—Liquid glass is the solution of a neutral silicate in one of its components; granite is liquid glass slowly cooled; lava, liquid glass suddenly cooled. Bronze slowly cooled is a solution of crystallized tin in amorphous copper, and bronze cooled suddenly is a solution of amorphous tin in amorphous copper.—Vide *Comptes Rendus*, January 25th.

A New Form of Safety-lamp for Miners has been devised by Mr. F. Foster. The most important feature in the invention is that the moment the lamp is opened the flame is extinguished. It is well known that many of the dreadful explosions which occur in our coal-mines result from the utter recklessness of the workmen, who open their safety-lamps for various purposes. Mr. Foster's lamp is constructed in such a manner that the ring or frame of the wire gauze when it is put into its place is caused to engage with a disk, which, when turned, raises or lowers the wick ; and on the gauze-frame is placed a spring catch, which, when the locking-ring is screwed into its place, bears against the interior. On this locking-ring is a catch which will only allow the spring catch to pass it in one direction, so that the gauze can only be turned (in order to raise the wick) so far as to bring the catch up to the stop on the locking-ring. In opening the lamp the locking-ring requires several turns to free its screw, and in the course of the motion the spring catch is brought up to the stop, the gauze is forced to turn, and the motion thus communicated to it lowers the wick, and so extinguishes the flame.

MICROSCOPY.

The Microscopical Society's Prizes.—Since our last issue, the meeting of the Council of the Microscopical Society, which was to have decided upon the merits of the instruments sent up for competition, has taken place. We regret to perceive that the result has been most unsatisfactory ; not only did none of the distinguished manufacturers send in microscopes for the Society's medals, but even those who did forward instruments complain bitterly of the mode of adjudication. Certainly there must be something wrong somewhere ; either the makers consider that the Society's medal is of no service as a guarantee to the public, or they consider that the judges are not as impartial in forming their decisions as they should be. It is not for us to say to which of these circumstances the result is due ; but the facts remain that the microscopes sent in for examination were, with one or two exceptions, those of manufacturers unknown to histologists, and that there has been a great deal of ambiguity concerning the exact nature of the decision of the Council.

The $\frac{1}{50}$ Inch Objective.—This, the wonder of all microscopists, has been manufactured by Messrs. Powell & Lealand for Dr. Lionel Beale. It is, without doubt, an exquisite glass, giving an extremely flat field and marvellous definition. Its angular aperture is smaller than the twenty-fifth inch of these makers, being 150°, and its price is thirty guineas. It was exhibited at the *soirée* of the President of the Royal Society on Saturday, March 11th, and the object displayed by it (the Podura's scale) proved the extraordinary qualities of the new power, the markings appearing almost like distinct scales. Its magnifying power under the No. 1 eyepiece is 2,500 diameters ; but, by employing the 5th eyepiece, it may be brought up to 15,000 diameters. When it is remembered that the lenses of this objective are themselves so small that the workman is obliged to use a microscope in preparing them, some idea may be formed of the difficulties attending their manufacture.

The new "Popular Microscope" of Messrs. Smith & Beck is a great improvement upon their "Universal" instrument, and bids fair to achieve popularity. It is intended for those who want a sound working instrument, not of the very highest finish, but at a moderate cost, and with all the accessory apparatus which the microscopist requires. It is sold at a low price, and, so far as we have seen of its lower powers, it has good definition and considerable penetration. The stand, though by no means handsome, is firm and solid, and upon a somewhat original plan.

"*Words on the Choice of a Microscope.*"—This is a little pamphlet reprinted from the *Microscopical Journal*, and which, we think, might very well have been left where it originally appeared. It contains nothing new, but lays great stress upon the advice (so often given by those who can afford to purchase expensive instruments) to the effect that no one about to purchase a microscope should dream of investing in a cheap stand. We do not agree with the writer. Of course a solid, firm stand is better than one which vibrates ; but let us ask the author how many of our students of the present day could afford to spend at the outset say £30 or £40 in the purchase of a first-class microscope ? It is very well for Mr. Plumer and those who can wait till they can afford to procure an expensive microscope, but this won't do for the student, who, when he becomes a professional man, is carried away in earning a livelihood from all those pursuits which, if followed while he was a student, would be afterwards developed. It is better far, in our opinion, to let those who desire to become conversant with Microscopic science, to spend £10 or £15 in the purchase of an instrument such as Smith & Beck's Student's or Highley's Hospital Microscope, with which they can learn far more than some folk are disposed to imagine, than to wait (as sometimes would happen) for six or seven years till they can afford one of Ross's or Powell & Lealand's first-class instruments. We perceive that the $\frac{1}{20}$ inch objective of Messrs. Smith & Beck has been omitted from the table appended to Mr. Plumer's brochure.

Highley's Field Microscope, which is a modification of Dr. Beale's instrument for class demonstration, is intended for the use of field botanists ; and, from the ingenious manner in which its stage is arranged, it is admirably adapted for the object for which the manufacturer intends it.

Diagrams of Microscopic objects are stated by Mr. Laing in the last *Microscopical Journal* as being of use to lecturers. Therefore he suggests that some of our enterprising publishers should issue a series of maps delineating the minute structure of plants and animals.

Mr. Goddard's Mounting Table is defended by its inventor against the accusations of Mr. Stokes. Mr. Goddard asserts that the Canada balsam, in which objects are mounted, is not liable to boil in the preparation of specimens upon the table devised by him.—*Microscopical Journal*, January.

For abstracts of papers on Histology, consult the following divisions of the Summary :—

Botany.
Medical Science.
Zoology and Comparative Anatomy.

PHOTOGRAPHY.

The Dublin International Exhibition.—The great respect for the new art-science of photography displayed by the Committee of the Fine Arts Department of the Dublin International Exhibition, by classifying it with the fine arts, promises to bear good fruit in the shape of an unusually admirable show of attractive and artistic specimens. The managers have done well also in grouping the separate collections contributed from different countries together, preserving their distinctiveness, and yet securing that amount of unity which is essential to comparing the relative degrees of progress made by foreign and British professors. By this means also a broader and simpler effect is obtained generally, and the student or observer is very much less wearied and confused in passing through so large, so greatly varied, and so important a collection. Those who visited the last international exhibition will understand the superiority of the Dublin arrangement to that of the Commissioners of 1862. The same spirit of order will be recognized in the classification of the various branches and departments of photography. It is evident that earnestness and singleness of purpose are at the root of efforts so judiciously and meritoriously conducted.

New Method of Printing.—A method of printing photographs on ivory and wood, first suggested in "The Art Student," and since then taken up experimentally and conducted to a satisfactory result, appeared recently in the pages of the *Photographic News.* Mr. G. W. Simpson, the editor of the above serial, thus describes the process :—

"We have used a collodion made from a somewhat powdery pyroxyline, saturated with nitrate of silver, and containing about four grains of nitrate of silver to each ounce. A tablet of ivory prepared for miniature-painting is coated with this collodion, and exposed under a negative. It prints somewhat more slowly than paper, tends to produce a more vigorous image, and requires very little over-printing, especially if submitted to a bath of dilute acetic acid before toning and fixing ; for we find that with Wothlytype prints the image is much less reduced during toning and fixing if it have been submitted to the bath of acetic acid and water first. By remaining in this solution five or ten minutes, the uranium salt is dissolved out of the film, and the print may now be submitted to the action of a toning and fixing bath, consisting of gold and sulpho-cyanide of ammonium, such as we have before described ; or it may be toned in a bath of chloride of gold and acetate of soda, and then fixed in a solution of sulpho-cyanide of ammonium, one part in ten of water. We have tried both plans, and with ivory have obtained the best results by using the acetate bath. A thorough rinsing completes the operation.

"When the picture is completed and dried, it possesses, of course, a surface of collodion. This, to some colourists, would not be regarded as an objection, the collodion surface being a very pleasant one on which to colour ; but for those who desire the peculiar surface of the ivory itself, the collodion may be easily removed. A few drops of ether are poured on the surface, and the film removed with a tuft of cotton wool ; the surface is finally rinsed with ether to remove the final traces of the collodion, and the picture is finished. It will be found that, notwithstanding the removal of the collodion, the image is not impaired, but remains vigorously impressed on the surface of the ivory itself. If the film of collodion were thick and of a horny character, the tone of the picture on the ivory will be a little redder than before the removal of the film ; but with a porous, permeable collodion, the toning action appears to pass completely through to the ivory itself.

"So far as the process is concerned, the operation is perfectly easy, and there appears to be no difficulty in getting good results; but there is one source of failure to be guarded against, which is in the preparation of the ivory itself. In our first experiments we used the tablets of ivory as sold by the artist's colourman, ready prepared for miniature-painting, the surface being apparently everything that could be desired. When the picture was finished, however, we were wofully disappointed; by some means or other a factitious surface had been given to the tablet, without really removing the saw-marks, which now appeared in deep but fine ridges, quite sufficient to spoil the effect, and give the appearance, besides, of a print which had not been in proper contact with the negative in the pressure-frame.

"In subsequent operations we found it desirable to prepare the ivory ourselves. This is very simply done. A suitable piece having been selected, as free from grain as possible, all traces of saw-marks must be removed by means of a steel scraper or a piece of glass. This being done, the ivory is placed on a piece of board, a few drops of clean water, and a little very fine pumice powder, quite free from grit, applied. The surface is then carefully smoothed by this, rubbing all over with a circular motion. A glass muller is the right thing to use, we believe; but we have found a new bung cork answer admirably. When every trace of mark or scratch of any kind is removed, the tablet is ready for use. If a little cuttle-fish bone in powder be used dry to finish with, the texture of the surface will be improved.

"There is, of course, a difficulty in printing on ivory not easily overcome entirely. It cannot be turned back like paper in order to examine the progress of printing. We have found, however, that if it be thin and care be used, it is possible to raise it up sufficiently to judge of the progress without any danger, and have done so in all the experiments we have tried.

"It is important to remember that for the purposes of the miniature-painter, a light, delicate, sharp impression, as full of detail as possible, and without dark shadows, is required. A soft negative will generally answer the purpose best.

"By using the same manipulations throughout, employing a prepared block of boxwood, the photograph may be printed on wood for the engraver, more simply and efficiently than by any other plan we know."

Photographing from Dead Eyes.—A large number of absurd rumours on this subject have appeared in our home and foreign contemporaries from time to time during the last few years. These marvellous stories, however, had been confined to the kind of paragraph which is used chiefly on the score of the merit it possesses of filling a stray corner when other more important matter is not handy or come-at-able. The editor of the *Morning Post*, however, has been betrayed into an error truly comical by devoting a leading article to the subject, in which his we-ship sagely asserts "our" faith in the story. The stupidity of the affair is seen when we tell our readers that the said image from a dead eye of a murdered person, which the photographer is said to have obtained, was on the *cornea* of the eye. Just fancy the extent of the aforesaid editor's scientific knowledge. The photographer concerned has since written to a contemporary describing the whole affair as a blunder.

Washing Positive Proofs.—Our Spanish contemporary *El Eco de la Foto-*

grafia says, "Experience has demonstrated the difficulty of removing from positive proofs on paper the last traces of the hyposulphite which has been used in the fixing. Among the various methods proposed for the complete removal of this salt, which if it be allowed to remain slowly destroys the proof, causing it to acquire a yellow colour, we proceed to explain that which has been suggested by M. Spiller.

"It consists in washing the proofs for an hour, changing the water in which it is done three or four times. The proofs are then placed in a solution of common salt-and-water (about 62 drachms of salt to 35 ounces of water), in which they are kept for twenty minutes; this solution may be used indefinitely; finally, they are washed for two hours in a current of water. The proofs at times retain some particles of the salt; the presence of which, however, in no degree alters its preservation, so long as they are completely free from the hyposulphite. This means is the simplest and best of the many that have hitherto been tried, since it does not require more than three hours and a half in place of the eight or ten hours that are generally employed in other processes, the result of which is often not very satisfactory."

Award of Medals.—The Photographic Society of Scotland have awarded the medals given annually by this society as follows:—Mr. H. P. Robinson (London); portraiture, for his portrait of "Brenda." Mr. James Mudd (Manchester); landscape, for his view of "Dunham Park." Mr. Thomas Annan (of Glasgow); best view in Scotland, for his "Dumbarton Castle." Mr. John Smith (Darnick Tower); best view by an amateur, for his picture, "On the Leader near Melrose." Mr. J. Ramsay L'Amy (of Nether Byres); for the best group. Mr. Samuel Highley (London); for a series of microscopic objects enlarged for the magic lantern. The Pantoscopic Company (London); for panoramic views taken with the pantoscopic camera. Few will question the justice of the various awards.

The Copyright Question.—The piracy of engravings by photographers, and the fatal injury thus inflicted upon a branch of art deserving the greatest encouragement, has been again before the public during the last three months, and it has been decided in one of the courts that the print-publisher's usual mode of disposing of proofs before letters robs him of the legal remedy which the law otherwise awards. This is a very important decision, and one which strikes at the very root of engraving as a branch of the fine arts.

Carbon Transparencies for the Magic Lantern.—Mr. Walter Woodbury, whose beautiful views of Japan are so well known, describes the following simple and effective process for obtaining these beautiful productions. Take a few sheets of talc about 3½ inches square, and place say 4 or 6 on a sheet of plate glass, 8 by 10, or 10 by 12, with their edges joined and surfaces damped, in order to make them adhere. A bichromated solution of gelatine, coloured as in Mr. Swain's carbon process, only to a greater extent, is used. The sheets of talc being coated with this solution, are allowed to dry. The talc is then taken from the glass and exposed to the negative, the gelatine side uppermost. When printed, wash in warm water, as in the carbon process above mentioned.

PHYSICS.

Origin of Meteorites.—As there is no subject which has given rise to so much conjecture in the minds of physicists as that of the source of meteorites, every new hypothesis is examined with interest. Among the many speculations as to the cause of these curious bodies, not the least attractive is that which has lately been put forward by Dr. Reichenbach, of Vienna. This savant believes in the existence of a cosmical powder or dust, which extends through all space, and which sometimes becomes agglomerated, so as to form large and small meteorites, which, at the time it reaches the surface of the earth, is in the form of an impalpable powder. It is known that meteorites are composed chiefly of nickel, cobalt, iron, phosphorus, &c., and as these are not common constituents of our soil, it has hitherto appeared impossible to refer the meteorites to a source in our earth ; but Dr. Reichenbach shows that the dust which covers the tops of mountains, that have never been touched by the implements of the miner, contains nickel, cobalt, phosphorus, and magnesia in notable proportions. Hence his conclusion as to the origin of meteoric bodies.

A useful Form of Magnesium Lamp has just been devised in Paris. The objections to the previous forms are—1st, the irregular illuminating power of the flame ; and, 2nd, the occasional extinction of the light. To obviate these difficulties, M. Matthieu Plessy employs a small hydrogen flame, in which the end of the magnesium wire is burnt. By these means an equable illumination is obtained, and the magnesium wire cannot cease to burn ; whilst the hydrogen flame being neutral, no injurious optical effects are produced.

Radiation of Dark Rays of Heat.—Some of the most interesting experiments which have ever been made in the investigation of the manner in which heat is radiated, are those which Professor Tyndall lately displayed at the Royal Institution. The lecturer's object was to show that after the rays of light proceeding from the electric points have been completely absorbed, the heat-rays still travel on, and appear to lose none of their intensity. The electric light was reflected by a concave mirror of about eight inches focus, and a cell of rock-salt, containing iodine in sulphide of carbon, was placed between the mirror and its focal point. By this means all the light was absorbed ; yet when objects were placed in the focus of the mirror, they instantly became inflamed. Wood painted black, when brought into the dark focus, emitted copious volumes of smoke, and was soon kindled. Paper, charcoal, mixtures of oxygen and hydrogen, zinc-foil, magnesium wire, and other metallic substances, were similarly affected. For a general expression of the phenomena thus produced, Professor Tyndall suggests the term *calorescence.*

Connection between Electric and Atmospheric Disturbances.—At the meeting of the Royal Society on Thursday, February 23rd, Admiral Fitzroy pointed out some very curious effects of atmospheric electricity upon the wires of telegraphs. It appears that at certain periods the electric wires become perceptibly affected ; and this, according to observation, cannot be attributed to any action of the batteries with which they are in contact. Whenever this phenomenon occurs in any part of the country, intelligence is immediately forwarded to the Admiral, who stated that he has found from experience that such disturbance of the electric wires is invariably followed by serious atmospheric changes, exhibited in the production of violent storms. The Admiral concludes that the atmospheric alteration is the effect of the electric change; and the latter he conceives to be also productive of the abnormal action of the wires. Professor Tyndall, who was asked for his opinion upon the matter, considered that the facts were not yet sufficiently clear to warrant an expression of decided views. So the matter rests for the present.

Standard of Electrical Resistance.—In reference to this subject, we have received a communication, which we subjoin for the benefit of those of our readers interested in electrical science:—

"6, Duke Street, Adelphi, London, W.C.

"Sir,—I have the honour to inform you that copies of the standard of electrical resistance chosen by the Committee on Electrical Standards, appointed by the British Association in 1861, can now be procured by application to me, as Secretary to the Committee.

"The standard is a close approximation to 10,000,000 metre-seconds in Weber's absolute electro-magnetic system, determined according to new and careful experiments made by different members of the Committee; and the copies are constructed of an alloy of platinum and silver, in a form chosen as well adapted for exact measurement.

"The want of a generally recognized standard of electrical resistance has been universally felt, and led to the appointment of the Committee. They now desire me to express a hope that the motives which have led to their present choice, and which are fully explained in the several reports published by them, will induce you to assist in procuring the general adoption of the new standard.

"I remain, Sir, your obedient Servant,
"Fleeming Jenkin."

Electro-Chemical Properties of Hydrogen.—A valuable article, showing the metallic properties of hydrogen, appears in *Les Mondes*, from the pen of M. Crova. The writer states in this that a metallic plate covered with hydrogen proceeding from the decomposition of an electrolyte, possesses an electromotive force, varying with the intensity of the current; that is to say, with the amount of gas disengaged in a given time at the surface of this plate, and which may be calculated exactly by means of a logarithmic formula. When mercury, containing a small but variable quantity of oxidizable metal, is employed as the negative metal of a pile, the electro-motive force diminishes rapidly with the quantity of oxidizable metal contained in the amalgam, provided the quantity is very small. The hydrogen disengaged at the surface of a metallic plate is always more or less in a condition similar to that of an oxidizable metal contained in minimum proportion in an amalgam. Mercury which has served as a negative electrode in the decomposition of water has the property of disengaging, when heated, bubbles of hydrogen; and when substituted for the zinc of a pile, it exhibits all the behaviour of an oxidizable metal, in which the proportion of this metal would be very small. Very pure mercury, through which a current of ordinary oxygen has passed, does not differ from simple mercury ; but this same mercury, after having been submitted to the action of a current of hydrogen proceeding from the decomposition of water by the pile at a low temperature, and containing consequently traces of Ozann's allotropic hydrogen, presented, though to a very slight degree, properties analogous to those of mercury which has served to disengage hydrogen electrolytically. From a number of facts like the foregoing, which experiments have shown him, the writer concludes (with Dumas) that hydrogen is a gaseous metal.—Vide report of M. Crova's memoir in *Chemical News*, February 17th.

Thermometer Alarum.—A curious instrument of this kind has been devised by M. Morin. The object of the apparatus is to give an alarm when the temperature falls below or rises above a desired degree. For example, in greenhouses, conservatories, &c., it is necessary to maintain a fixed temperature, but it is not always convenient to keep a man watching the thermometer. By means of M. Morin's instrument, the change of temperature is indicated by the ringing of a bell, which at once calls the attention to the alteration of heat. The apparatus consists of an ordinary thermometer, into the bulb of which a platinum wire is carried, another being brought through the top down to the point marking the degree of heat required. These wires are placed in connection with a small battery and electric alarum. So long as the required temperature is maintained, the circuit is complete ; but the moment the heat is diminished, the mercury falls, the circuit is broken, and a small electro-magnet lets fall an armature, which completes a circuit with the alarum. This now begins to ring, and continues to do so till the temperature rises again to the proper height. The principle involved in the machine is similar to that on which our automatic railway signals are constructed, and we only wonder it has not been put in operation before.—Vide *Comptes Rendus*, January 2nd, 1865.

Electricity and Music.—It is stated by a contemporary that Mr. Barker, an organ-builder of Paris, is the inventor of a mode of applying electricity in the construction of great organs, so that the largest organ may be played as easily as a pianoforte, and the pipes may be distributed anywhere through a church. The invention is now being applied to a large organ in course of construction for the church of St. Augustin, in Paris.—Vide *The Artizan*, January.

Colour-Tops.—In our last number we described a form of the philosophic toy known as the colour-top, which had been devised by Mr. Swift, of Liverpool. It appears that the subject of the *trocheidoscope* has been lately discussed at a meeting of the Liverpool Architectural Society ; and in reference to some remarks made on that occasion, Mr. G. A. Audsley thus explains the contrivance arranged by him :—"The general principles on which my instrument is constructed are the same as those on which the instruments invented some years ago by Mr. Rose are arranged. All I can claim for my machine is that, by adopting a vertical position for my revolving disks instead of the usual horizontal one, and by a very brilliant mode of illumination, I render the effects of colour visible at a great distance, and to any number of persons at a time. I have also introduced a series of compound motions, by which I obtain some striking effects, as well as continuity. Although I may have done a little towards the development of a very interesting and useful class of instrument, I lay claim to no credit connected with it, much less to being its inventor."

The Problem of Mahomet's Coffin.—M. Plateau undertook last year a series of experiments, with a view to discover whether, by any combination of magnets, he could suspend a metallic body in mid-air, as Mahomet's coffin is supposed to be maintained; and the result was his conclusion that the condition is an impossible one. This led to considerable discussion upon the question; and a letter appeared from Mr. W. F. Bartlett, of the Royal Institute, in the pages of the *Reader*, fully confirming M. Plateau's view. In this, however, he described a beautiful experiment, which may be new to our readers. A piece of gold leaf, about two and a half inches long and an inch and a quarter wide, was cut into the form of a kite, one end forming an obtuse and the other an acute angle. A large Leyden jar, with an elevated knob, having been charged, the gold leaf, lying on a piece of paper, was presented to it. It was sometimes necessary to detach the leaf by the aid of a penknife; when detached, it sprang towards the knob, but stopped within two inches of it, and remained hovering in the air. Its tail waved like the tail of a fish; and when a point projected from its side, it rotated continually. The jar when carried through the room was followed by the fish, which continued to swim in the presence of the knob for nearly an hour. With smaller jars and smaller fragments of gold, the same experiments may be made.—Vide the *Reader*, February 11th.

ZOOLOGY AND COMPARATIVE ANATOMY.

The Mammary Gland of the Echidna hystrix.—The *Echidna hystrix*, or porcupine ant eater, is one of those curious monotremes found only in Australia and Van Diemen's Land. For many years the history of its extra-uterine development has been a sealed book to zoologists; but the beautiful and elaborate memoir which Professor Owen has just presented to the Royal Society, upon the anatomy of the mammary gland of this creature, has entirely cleared up our notions concerning the lactation of the lower monotremata. Like the milk-gland of other mammals, the secreting organ of the Echidna is of a lobular character, that is to say, it is composed of a number of cæca bound together with connective tissue, and supplied abundantly with blood-vessels. Whilst, however, in other mammals, the general cavity into which the lobules open is connected with a teat, through which the young animal receives the milk, in the Echidna this receptacle absolutely receives the head of the young creatures. Professor Owen has demonstrated this fact incontrovertibly. Thus the Marsupalia carry their young in a pouch, which is a veritable cradle, in which they are nursed, but the Monotremes simply present a cavity into which the nurseling can only place its head, and so receive the nutritious secretion from its mother. The Professor has found that the claws of the anterior limbs are quite disproportionately developed in the young Echidnæ, attaining a considerable size; this he believes is to enable them to attach themselves to the mammary pouch, and thus prevent the strain that otherwise would fall upon the neck. As far as an examination of the uterus went, there was no trace of placenta exhibited; and hence Professor Owen concludes that the Echidna may properly be grouped along with the other monotremes in the division *Aplacentalia*.

How Birds Fly.—Birds, like insects, can progress by flight in three distinct ways: (1) Flight without locomotion; (2) with locomotion and beating of the wings: and (3) without beating of the wings. The second is the method most generally adopted, and appears to require less labour, the rapidity of the wing movements being less than in the other modes. The cause of this is, that the wings experience no resistance in ascending. When a bird is about to depress its wing, this is a little inclined from before backwards; but the movement is accompanied by a rotation of several degrees round the anterior edge, so that the wing descends more in front than behind, and the descending movement is transferred more and more backwards, at the same time that the wing becomes more and more inclined, so as to give simultaneously an ascending and accelerating horizontal advance. Towards the close of the movement, a fresh rotation takes place round the anterior margin of the wing, but in the opposite direction, so as to bring the posterior part on a level with the anterior, or even a little below it. This also produces an ascending movement. When the wing has completely descended, it is both further back and lower than at the commencement of the movement; but, as at this commencement, its posterior part is a little lower than its anterior. It is then raised in this position.—Vide a memoir by M. E. Liais, in *Comptes Rendus*, November.

Temperature required for Incubation of Hen Eggs.—M. Dareste narrates the results of some curious experiments which he made to determine the lowest temperature at which hen eggs could be hatched, or rather at which embryos could be developed. He has found that incubation may go on at as low a temperature as 30° of the centigrade thermometer. The embryos, however, which are produced at a temperature of from 30° to 34° are very slowly developed. None of them ever emerge from the shell, as all perish before arriving at maturity. Some of them die earlier than others; but none of them reach that period when the embryo surrounds the vitellus. Most of the embryos which underwent incubation in this manner were monsters. Some presented anomalies of the head, of which the Cyclops variety was most frequent; others presented a double heart; and in some cases both these abnormal conditions were present together.—*Comptes Rendus*, January 9th.

The Metamorphoses of Fishes.—The subject of the metamorphoses of animals is one of great interest to the zoologist, and therefore the newly-announced facts recorded in the memoir presented by M. Agassiz to the French Academy will produce considerable excitement in the Natural History world. Although M. de Quatrefages in his recent essay admitted that certain fish undergo slight alterations in point of structure, subsequent to the absorption of the vitelline sac, yet he had (at the time of writing his work) no idea that such extreme alterations occur, and are of such general occurrence, as are now asserted to take place. Agassiz, who may fairly be regarded as the most distinguished living ichthyologist, states that he has observed as important metamorphoses among fish as those which occur in the case of reptiles. He has seen certain young fish, which apparently belonged to the families *Gadidæ* and *Blennidæ*, gradually assume the forms characteristic of the groups *Labridæ* and *Lophidæ*. He thinks, too, that he can demonstrate that certain species which in their immature condition resemble the tadpole of the frog, take on afterwards the typical character of the Cyprinodonts; that certain apodal fish assume the structure of those which have pectoral fins; and that some *malacopterygii* become in course of their development *spiny-finned.* Recently he has discovered metamorphoses among members of the mackerel family, and in these cases the changes undergone are more remarkable than those alluded to above. All ichthyologists are familiar with the generic character of the doree, which is termed *Zeus faber*, and with the morphological peculiarities which associate this animal with the mackerel group. There is another fish, less known to naturalists, which inhabits the Mediterranean, and is termed *Argyropelecus hemigymnus*, and is supposed to be related to the *Salmonidæ.* Now, there are hardly to be found two more distinct families than those of which the salmon and mackerel are representatives; yet, marvellous to say, the *Argyropelecus hemigymnus* is nothing more than the young of *Zeus faber.* Agassiz admits that his assertion is a very startling one, but he calls upon zoologists to repeat his observations, and he contends that his statements will be fully borne out.—Vide *Comptes Rendus.*

External Auditory Hairs of Crustacea.—Herr Dr. Von Hensen has published a valuable memoir upon the auditory organs of decapod crustacea, in which, among descriptions, he gives an account of the external hairs connected with the sense of hearing. These hairs are especially numerous in those species of the Carides which have no internal auditory organs. The hairs are situated upon the basal portion of the inner antennæ, and on the second joint of the outer pair. They are found also on the tail. The characters common to all forms of these auditory hairs are thus summed up:—(1.) They are always implanted over a hole in the chitinous membrane. (2.) The border of this hole is always elevated on one side into a sort of tooth. (3.) The stem of the hair does not rest directly upon the hole, but is supported by a very delicate membrane, which is often dilated, so as to form a sort of ampulla at the base of the hair. This arrangement is calculated to isolate the hair from any agitation proceeding from the interior of the body, and at the same time, perhaps, to facilitate its vibrations. (4.) The stem of each auditory hair presents a sort of appendage, to which the nerve of the hair is attached. Properly speaking, the nerve terminates in a ganglion-cell before it reaches the hair; but from this cell arises a minute and slender nerve-cord, which enters the canal of the hair, and is attached to the stem appendage. The other superficial hairs do not exhibit similar complexities of structure, and, in particular, are wholly devoid of any nervous cord.—Vide Abstract of Dr. Hensen's paper in *Microscopical Journal*, January.

The Development of the Marine Crustacea, especially as concerns the larvæ of *Palinurus*, has been carefully studied by M. Gerbe. He shows that the larva of the *Palinurus* of our seas does not resemble the typical *Phyllosoma;* thus it does not present a trace of the false feet which are attached to the abdominal segments of *Phyllosoma*, the last of these segments being simple, instead of terminating with a fin composed of five laminæ. But though at first it does not exhibit the character of *Phyllosoma*, M. Gerbe shows that it does so after the fifth moult. He states that on witnessing the hatchings of the marine crustacea, and following their development, we find that all make their appearance in a larval form, and that immediately after their birth all of them undergo a first moult. They detach themselves from the epidermal envelope in which their ovarian development was effected; and when they are entirely separated from it, organs which were before invaginated like the slug's eye, became everted. Such is the case with the spines of the cephalothorax, the last joint of the foot jaws, and true feet, the ciliated fringes of the temporary swimming organs, and the spines, hairs, and filaments which clothe the antennæ and final somite of the abdomen.—Vide *Comptes Rendus*, December 26th and January 9th.

New Silkworms.—At a meeting of the French Academy, January 23rd, M. Guérin-Méneville presented a note on a new sub-genus of Bombycides producing silk. The animal is termed *Saturnia Bauhiniæ*, and is an inhabitant of Senegal. For this the author proposed to form a new sub-genus, under the title of *Faidherbia*, in honour of General Faidherbe, the commander of the French military expedition in the district of the Senegal, through whose instrumentality the silk-producing qualities of the insect have been made known. Each cocoon contains 633 milligrammes of silk, those of the common silkworm containing only 290, and those of the silkworms of *Ailanthus* and *Ricinus* only 255 and 175 milligrammes respectively. It is proposed to introduce the cultivation of this new silkworm into Algeria.—Vide *The Reader*, February 18th.

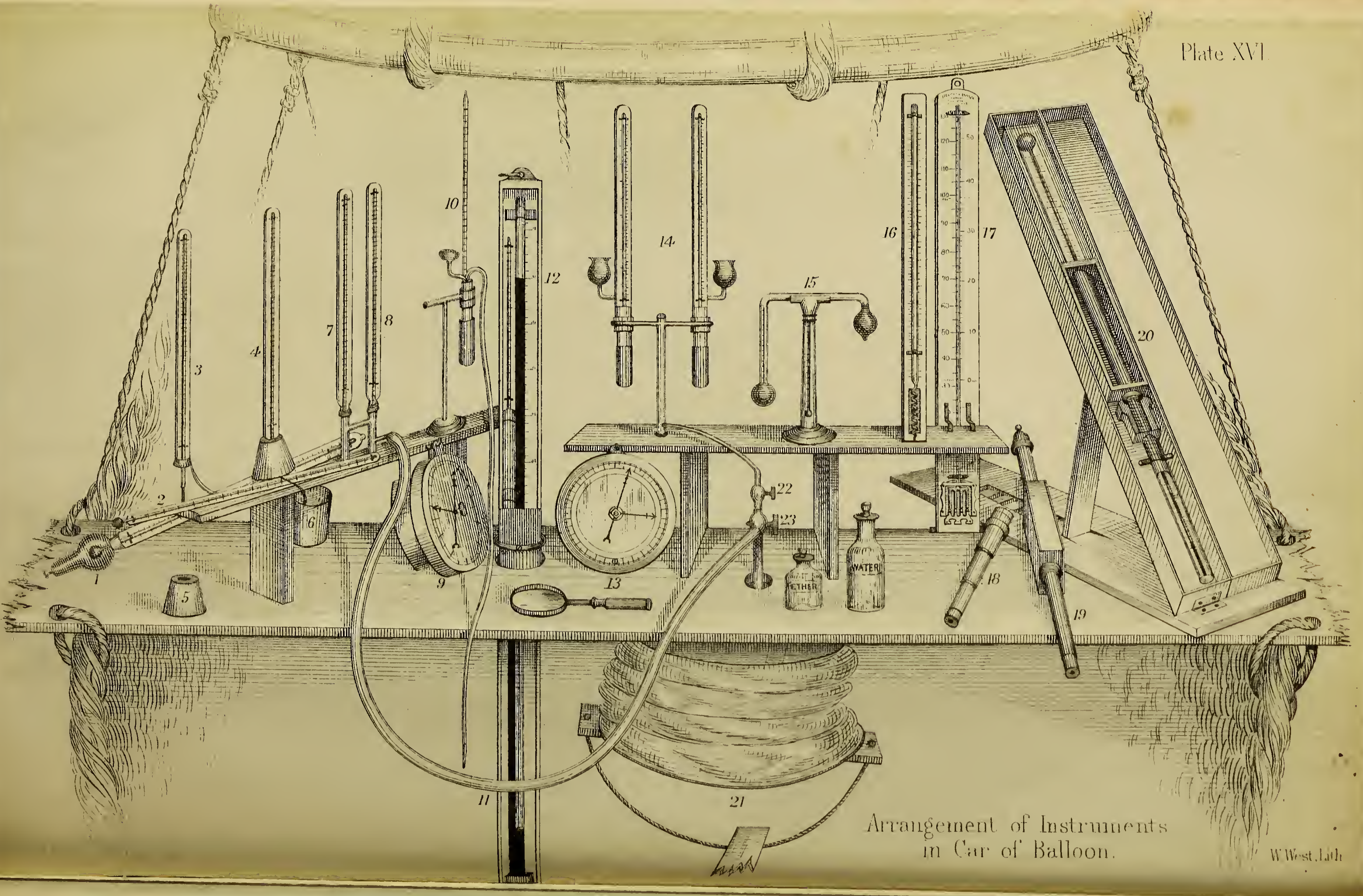
Cervical Vertebræ of the Two-toed Sloth.—Professor Peters read a paper on this subject before the Academy of Sciences of Berlin, at one of its meetings in December last. The only exceptions to the rule that mammalia possess seven cervical vertebræ have hitherto been the genera *Bradypus* and *Manatus*, the former genus having from eight to ten, and the latter only six, neck-bones. The Professor has added another to the list of exceptions: this is a species of two-toed sloth, which he described in 1858 under the name of *Cholœpus Hoffmanni*. He has in his possession several skeletons of this edentate, and in none of his specimens do the cervical vertebræ exceed six in number.

A Journal of Conchology, to be published quarterly, is about to make its appearance on the other side of the Atlantic. It will be entirely devoted to Molluscan Zoology, and the subscription will, we understand, be ten dollars per annum.

The Anatomy of Monkeys has been ably discussed by Mr. St. George Mivart, F.Z.S., in a series of papers read before the Zoological Society, and which will appear at length in the "Proceedings" of the Society.

BRITISH MUSEUM

Plate XVI



Arrangement of Instruments
in Car of Balloon.

W. West, Lith.

BALLOON ASCENTS, AND THEIR SCIENTIFIC IMPORTANCE.

BY JAMES GLAISHER, F.R.S.,

PRESIDENT OF THE MICROSCOPICAL SOCIETY, ETC., ETC.

SEVENTEEN years before Gay-Lussac made his balloon ascent for the advancement of science, M. De Saussure, of Geneva, performed his memorable journey of ascending to the summit of Mont Blanc, and succeeded in making observations at the height of 15,000 feet and upwards; an achievement which had been the desire of his life. This was in the year 1787, four years after the first ascent of a hydrogen-gas balloon with Messrs. Charles and Robert, from Paris.

The weather was favourable, the snow was compact and hard. The party consisted of De Saussure, his servant, and eighteen guides. There was no difficulty or danger in the early part of the ascent, their footsteps being either on the grass or the rock itself. After six hours' incessant climbing the party found themselves 6,000 feet above the village of Chamouni, from which they had started, and 9,500 feet above the level of the sea. At this height De Saussure and his party prepared to encamp, and to pass the first night. They slept under a tent on the edge of the glacier of the Montagne de la Côte. By next day at noon they were 2,000 feet above perpetual frost; and after eight hours' climbing on the second day, they were 13,300 feet above the sea, having made less than 4,000 feet of vertical height during the entire day. Here they passed the second night. The guides had to dig out the snow for their lodging. Into the hollow thus made some straw was thrown, and across it a tent was stretched. Their water was frozen; but they were furnished with a small charcoal brazier to melt snow, which, for twenty persons, proved insufficient.

The cold next morning was excessive; but before they could again depart on their toilsome journey, they had to melt snow for their breakfast and to serve on their journey to come.

On starting on this the third day, the rarefaction of the air affected their lungs, an inconvenience increasing step by step. But little advantage was found by frequent prolonged rests, made in the hope of recruiting their strength; at every dozen steps they were again compelled to halt to recover breath, and thus toiling at last the summit was reached.

On arrival here, the keenest impression was one of joy at the cessation of labour and great anxiety; for the prolonged struggle, and the recollection of the sufferings this victory had cost, says De Saussure, produced rather a feeling of irritation, and he stamped his foot, he says, more with a sensation of anger than pleasure. His object was not only to reach the crown of the mountain, but to make such observations and experiments there as would alone give any value to the enterprise, and he began to be afraid lest he should fail in his intentions in this respect. He had already found out, even at a much lower elevation, that every careful observation in such an attenuated atmosphere was fatiguing, on account of the necessity of holding the breath whilst thus engaged; and as the tenuity of the air at this elevation necessitated increased frequency of respiration, this suspended breathing caused De Saussure a sensible feeling of uneasiness, and he found himself compelled to rest and pant after each careful observation as after having mounted one of the steepest slopes.

Four hours were thus spent on the top of the mountain, three hours and a half being devoted to observations and experiments on the summit, when the party began to descend. They passed the night (the third since they left Chamouni) on Les Mulets, and De Saussure writes:—

> At the moment of my reaching the summit I did not feel satisfied; I was less so when I left it. I only reflected then on what I had not done. But, in the stillness of the night, after having recovered from my fatigue, when I went over the observations I had made, I enjoyed a true and unalloyed satisfaction.

The simple narrative of this eminent man is throughout a commentary upon the use of a balloon for the purpose of exploring the higher regions of the atmosphere. This ascent—the one great fact of De Saussure's life, the accomplishment of the wish of twenty-seven years—to what did it tend? Of what value to science is one isolated day's experience? What can a single set of observations amount to, except to appease curiosity? Up to this time, however, all our knowledge of the physical state of the upper atmosphere was based upon the observations which for ages had been made on mountain sides, yielding results always differing from each other; and, up to the time of the balloon, we had no means of ascending into the air at all to test the conditions of the atmosphere apart from the terrestrial influences and the inevitable labour of ascending the mountain's side. The results thus found were of necessity disconnected; for the time occupied between one elevation and reaching another was so great that the two could not be otherwise than very loosely related.

When, therefore, the first balloon ascent was made with human beings, who recorded the history of their sensations and the conditions of the atmosphere at various elevations, as the natural incidents and circumstances of their voyage, a practical application of the balloon to the purposes of those aërial researches of De Saussure was thus spontaneously suggested.

Seventeen years, however, passed before Gay-Lussac solicited the French Government for the use of the balloon in which he ascended to the height of 23,000 feet. Very great were the expectations, and much disappointment followed this memorable journey.

Account had not been taken of the want of sensitiveness of the instruments, and that the balloon would be constantly moving, so that readings taken at one elevation really belonged to another, either much below or much above, according as the balloon was ascending or descending, through that space of time required for the instruments to take up true readings. When far more sensitive and accurate instruments were constructed, by modern opticians, a desire again arose to ascend into the atmosphere, and the British Association appointed a committee, consisting of Col. Sykes, M.P., the Astronomer Royal, Lord Wrottesley, Sir David Brewster, Sir J. Herschel, Bart., Dr. Lloyd, Admiral Fitz-Roy, Dr. Lee, Dr. Robinson, Mr. Gassiot, Dr. Fairbairn, Dr. Miller, Dr. Tyndal, and myself, for carrying out these experiments; and it is under this committee the experiments have been made.

Elevations by means of the balloon are gained so easily, and without fatigue, that an observer, thus situated at different heights, separated from all connection with the earth, and quite free from any unpleasant sensation till he passes beyond three miles, is by far better situated than the Alpine traveller. He can prove the history of physiological sensations, and best pursue physical researches generally. In this case he travels free from the effects of muscular exertion, which makes fatigue so formidable in the higher regions of the earth's surface; and, apart from all terrestrial influence, can investigate the true conditions of the atmosphere, with instruments complete, carefully arranged, and always ready for use; advantages which speak for themselves. He can also repeat to-morrow that which he has done to-day, and successively in the different seasons of the year.

It will be convenient here to speak of the subjects of research by means of balloons with which I was charged.

The first in importance was the confirming or otherwise the result obtained from the observations on mountain sides, on the decline of temperature with increase of elevation—viz., the lowering of temperature of the air 1° for every increase of elevation of 300 feet.

The next in order of importance was the law of the distribution of the water in the air, in the invisible shape of vapour, near the earth, near clouds (but below them), in different kinds of clouds, and at high elevations above the clouds. These determinations to be made by the use of different instruments — viz., by Daniel's hygrometer, Regnault's condensing hygrometers, by dry- and wet-bulb thermometers, as ordinarily used, as well as when under the influence of an aspirator, so that considerable volumes of air could be made to pass over both their bulbs at pleasure.

To compare the results thus found together: firstly, to determine whether Daniel's or Regnault's hygrometer were the better instrument; secondly, to compare the results as found by the use of the dry- and wet-bulb thermometers, as in common use, with those under the action of the aspirator; thirdly, to determine what confidence could be placed on the use of the dry- and wet-bulb thermometer at high elevations, but particularly up to those heights where man may be resident, or where troops may be located, in the highlands and plains in India.

To determine the effects which the sun produces upon delicate thermometers, exposed to its full influence, at different heights, in excess above the readings of equally delicate thermometers protected from the direct beams from the sun; and also the effect the sun exercises on the readings of Herschel's actinometer, at different heights, when fully exposed to his rays at different elevations, in comparison with the increase of readings in the same interval of time when on the ground.

To determine whether the solar spectrum, when viewed from the earth, and when examined far above the earth, exhibited any difference; whether there were more or less black lines crossing it; whether these lines were better defined or not; and whether, towards sunset, there was any increase in the number of these lines.

To compare the readings of mercurial barometers and aneroid barometers together.

To determine the electric state of the air.

To determine the oxygenic conditions of the atmosphere by means of ozone papers.

To determine the intensity of magnetism.

To collect air at different elevations.

To note the kinds of cloud; their heights at their lower and upper surfaces; their density, &c.

To collect information about the currents of the atmosphere.

To make observations on sound.

To make physiological observations.

To note atmospheric phenomena in general.

To attain these objects, it was necessary to think well in respect to the kind and character of the instruments to be used, as well as to their arrangement for use.

The instruments, of necessity, must be of extreme accuracy and delicacy; and upon their convenient arrangement, in so confined a space as the car of a balloon, a great deal was dependent. The kind of instruments used, and their arrangement in the car of a balloon, are shown in Plate XVI., as prepared for observation.

Near one end of the car was placed a board or table, the extremities of which rested on the sides of the car, and were tied to it. Upon this board were placed suitable frameworks to carry the several instruments, arranged as shown in the Plate. At the extreme left hand (1) is shown a blackened-bulb thermometer with its bulb in a vacuum tube; just above it (2) is placed a very delicate blackened-bulb thermometer—both these instruments were exposed to the full rays of the sun; at (3) and (4) were placed delicate dry- and wet-bulb thermometers, these instruments were covered with double highly-polished silver caps, in the form of a frustum of a cone, open both at top and bottom; that for the dry-bulb is shown at (5), being removed to show the form of the bulbs of these thermometers; that for the wet-bulb is placed *in situ*. At times, additional protection was applied to these instruments. From the wet-bulb (4) the conducting thread is seen passing from the muslin covering the wet-bulb beneath the silver cone to the water vessel (6), from which water was conveyed to the wet-bulb thermometer. The next instruments in order are a similar pair of dry- and wet-bulb thermometers (7 and 8): these were inclosed in two silver tubes placed side by side, and connected together by a cross piece joining their upper ends, and over both were placed double shades with spaces between them (not shown in the Plate), as in the other pair of thermometers. In the left-hand tube was placed the lower end of the stem and bulb of the dry thermometer; and in the right-hand tube, the same parts of the wet-bulb thermometer; towards the lower end of the left-hand tube there was an opening; by means of the aspirator, to be spoken of presently, a strong current of air was drawn in at this aperture, then passed the dry-bulb, in its upward passage into the small horizontal tube, and from thence into the right-hand tube, passing downwards over the wet-bulb, and away by the flexible tube to the aspirator under the table. Near to these instruments was placed a watch or chronometer (9) adjusted to Greenwich time, resting on the table, but hanging to a hook in the framework. The next instrument on the framework was a Regnault's hygrometer with a single silver cup (10), with a tube leading from it with a glass terminal of sufficient length, that when blowing into it by the mouth, any other instrument, at any part of the table, could be read. Next to this instrument was the mercurial barometer, a perforation being made in the table admitting its lower branch to descend below (11), leaving the upper branch (12) at a convenient height for observing, with respect to the other instruments. Near to this instrument was placed a large aneroid barometer (13), its lower part resting on the table, while its upper part was fixed to the framework; above this instrument, placed on the framework, was a second Regnault's hygrometer (14) with a pair of gold cups; in the lower part of its central supporting stem there was an open projecting pipe, with flexible tube attached, leading to the aspirator below. A Daniel's hygrometer (15) occupies the next position, conveniently placed for inversion with the right hand, and admitting a ready perception of the first appearance of dew, being nearly central among the instruments; beyond these are placed two exceedingly delicate thermometers, the one with a spiral bulb (16), and the other with a gridiron form of bulb (17); beneath these, resting on the table, are two spectroscopes (18 and 19), and at the extreme right hand (20) Herschel's actinometer; on the table, besides, is a lens with bottles of water and æther. Beneath the table the aspirator (21) was fixed, near the centre of the table, so as to be conveniently worked by the hands, by taking hold of both sides, or by the foot resting on the trestle beneath. Holes were cut in the board to admit the passage of the flexible tube from the dry- and wet-bulb thermometers and the flexible tube from Regnault's hygrometer, previously referred to, both of these tubes being furnished with stop-cocks (22 and 23).

Whilst this operation was proceeding, the readings of other instruments were taken and recorded till the time approached when undivided attention was required to the right-hand gold cup of instrument 14, in comparison with its left-hand gold cup, to note the first dimming of the bright surface of the former by the deposition of moisture upon it, then to cease working the aspirator to read both the instruments of 14 and then to read instruments 7 and 8.

The mercurial barometer employed was a Gay-Lussac's siphon. The inner diameter of its tube is ¼ of an inch. The graduations were made on a brass scale from its middle point upwards and downwards; each division was about 0·05 inch in length, representing twice that value; so that an observation of either the lower or upper surface of the mercury would give the approximate length of the column of mercury.

The barometer was furnished with its own thermometer, whose bulb was immersed in a tube of mercury of the same diameter as that of the barometer. The readings of this thermometer frequently read from 30° to 40° in excess of those of the sensitive thermometers.

The bulbs of the sensitive thermometers were long and cylindrical, being about $\frac{3}{4}$ inch in length, and $\frac{1}{12}$ inch in diameter. The graduations extended downwards to minus 40°, and were all on ivory scales. These thermometers, on being removed from a room heated 20° degrees above that of an adjoining apartment, acquired the temperature within $\frac{1}{2}$ a degree in 10 seconds; but on taking the thermometer back to the heated apartment it took nearly double the time to rise to within $\frac{1}{2}$ a degree of the true temperature. They were sufficiently sensitive, therefore, for my purposes, and no correction ordinarily is needed for sluggishness except only when the balloon was moving with great and unchecked rapidity.

Besides the instruments shown in the Plate, there were ozone papers pinned to the table and to the cordage near, a compass, magnetical instruments, my note-book, &c. My position was in the front of the table, almost equidistant from the extreme right and left instruments.

The successful working of these instruments depended very much, as I have before said, on their arrangement, a quick eye, and the orderly habit of a trained observer; the arrangements of reading of every instrument, and of every subject of investigation were such that the one constantly checked the other; any erroneous reading of the dry-bulb thermometer, for instance, was shortly detected by the reading of differently graduated, spirit, or gridiron-bulb thermometers, and any systematic error in the reading of the wet-bulb thermometer was checked by the observations of the hygrometers, whose readings, though related, were very different. Thus the arrangements included a system of checks, so that it was not possible to continue erroneous readings, when either the instruments needed attention, as the wet-bulb requiring more water, or the water not frozen on it when it ought to be, or still frozen when it ought not to be (in the latter case requiring the immediate application of heat, the only source of which in the balloon is the mouth), or from the painful state of the observer at times, losing to some extent the power of accurate observation. These arrangements were necessary, the situation of an observer in a balloon being so peculiar, and there being no means afterwards of discovering erroneous observations, if not discovered at the time, or the means of discovery be included in the arrangement of the series of observations. It remains to mention that the arrangements must also include that every instrument be screwed down to the table or framework, so that no lurching of the balloon, no vibration of the car from dropping the grapnel, and no accident, can displace them; everything else must be tied with rope of sufficient length for use and safe when out of use; for instance, the lens, which comes into active use when at high elevations, where the eye loses some of its power, must be fixed to cordage near the right hand with string of sufficient length that it can be directed to any instrument; in fact, every instrument must be screwed down if to be kept firm, and everything else tied, and all so arranged as to be readily removeable.

The object of this communication is to give the reader a sketch of the operations in balloons for such investigations; the nature and arrangement of the instruments used, and some of the results found. It is not the object, nor would the allotted space admit, to speak at all upon the management of balloons, with which, indeed, I had nothing to do further than indicating when to control the rate of ascending or descending in each stratum, so that the instruments might have sufficient time to take up true readings.

In speaking of the results obtained, it will be convenient to keep each subject of investigation separate, and first I shall speak of the Decline of Temperature.

In every ascent the series of observed temperatures, when compared with the calculated temperatures at the rate of 1° decrease for every 300 feet, were found to be very different, and that these differences, with different ascents, when compared, did not agree. The most marked differences, in this respect, were found dependent on the state of the sky, which exercised a great influence, and the experiments had to be divided into two groups, one with clear or nearly clear skies, and the other with cloudy skies; the decline of temperature being the more rapid with skies free from cloud.

I will first speak of the results with cloudy skies as based upon all the experiments under those circumstances.

At 1,000 feet high the decline was 4½°; in the second and third thousand there was a further decline, a little more than 3½° in each thousand feet; this amount decreased to 3° between 5,500 and 6,500 feet, and was less and less in each successive 1,000 feet, till it was as small as 1° in this space at about 21,000 feet high.

Therefore, an average space of 223 feet was passed for a decline of 1° up to the first 1,000 feet, this space becoming greater, till at an elevation of 21,000 feet, the sky being still obscured by cloud, a space of fully 1,000 feet had to be passed for a decline of 1°.

Up to 5,000 feet the results are based upon experiments varying from 13 to 22; at 6,000 and 7,000 feet to 7 and 5 respectively; from 7,000 to 16,000 to 4 only; these having been made on two days in 1863, June 26 and September 29, on which days the balloon was frequently enveloped in fog and clouds to the height of three and four miles, and those above 16,000 feet on the former of these two days only, during the ascent and descent; the sky being still covered with cloud, when the balloon was between four and five miles high.

I may here remark upon the fact of passing through clouds situated three and four miles high, and finding clouds higher still. Clouds of a dense character were previously supposed to be always located very much nearer the earth; and to one class of clouds alone, viz. the cirrus, commonly called mares' tails, was attributed elevations at such great heights.

With clear skies the decline of temperature within the first 1,000 feet was 6¼°; in the next, 4¾°; and decreasing continually with elevation, till at 27,000 feet the decrease in 1,000 feet was 1° only. Up to the height of 22,000 feet, the number of experiments had varied from 7 to 17 in each step of 1,000 feet, and there can be but little doubt that the numbers resulting from so many experiments are very nearly true.

The space necessary to pass through for a decline of 1° of temperature, is less than one hundred feet near the earth; averaging 162 feet for the first 1,000 feet, and at heights exceeding 25,000 feet, it is necessary to pass through 1,000 feet of vertical height, for a decline of 1° of temperature.

I have endeavoured, thus far, to give the results for temperature. They differ in both states of the sky from the results found from mountain observations, and, consequently, this value can no longer be used in any physical investigations where needed. Without exception, the fall of 1° has always taken place in the smallest space when near the earth, and the space continually increases the farther removed from the earth.

These results were those based upon summer observations, made when the sun was well up, or during the hours of the day. A question then arose, "Will the same laws hold good in all seasons of the year, and will the laws during the day be true at night in that season of the year?" To answer these questions, experiments have been made in different seasons, and at different hours of the day. It was found, even in summer, that the rapidity of the decrease was checked for some time before sunset, and that, on one occasion, in the month of June, there was found to be no difference of temperature from the earth for 2,000 feet above it; and on another day, in the same week, the change of temperature after the sun had set, was very small up to 3,000 and 6,000 feet. From these results, it seems probable that, for some time after sunset, the temperature may increase instead of decrease, for some distance from the earth; but no experiments have, as yet, been made at night.

The results as found in winter, spring, and autumn, do not accord very closely with those found in summer, and therefore all the results cannot, as yet, be combined to deduce general laws. In winter, on January 12th, a stream of air one mile in thickness was passed through of higher temperature than then on the earth. It was a strong current of air, about a mile in height, passing from the south-west, and moving differently from the stream of air on the earth's surface; above this warm stratum the air was very dry, and higher still fine granular snow was falling into the warm air beneath.

The meeting with this south-west current of air, which was watched for several days afterwards, moving in the same direction, what direction soever the wind was below, is certainly of the highest importance to us. It bears directly on our very high mean temperature in winter, so much higher than is due to our geographical position on the earth's surface, and it is very highly probable that to its fluctuations the variation of our winters are due.

The high winter temperature has hitherto been referred, for the most part, to the influence of the heated water of the Gulf-stream; but if this was the case, the same agency being at work around the coasts of France should exercise the same warming influence; yet we know that the winters of France are more severe than our own.

Upon this matter, Dr. Stark, of Edinburgh, in writing some years since on the mildness of the winters in Britain, attributed them to the prevalence of the south-west or anti-trade wind, which is the prevailing aërial current in Britain during winter. He remarked, that as long as these winds blow, we experience no frosts nor intense colds; but the moment the wind changes during winter to an easterly, north-easterly, or northerly direction, we have both frost and snow; and more or less intense cold. The south-west winds in their course meet with no obstruction in coming to us, but blow directly to Norway, and to us over the level Atlantic; and hence, it seems probable, we enjoy a much milder climate during winter than any other countries not similarly situated with respect to such winds.

The south-west winds cannot reach France till after they have passed Spain, and crossed the high and cold mountain range of the Pyrenees; and by the time they have crossed that mountainous country, they are deprived of so much of their high temperatures, that France can derive comparatively but little heat, if any, from them, and hence, apparently, is due her cold winters. One other fact I may refer to in respect to the circumstance met with on that day, it is the presence of cold snow above the warm air. Such a state of things is quite sufficient to account for the production of any amount of fog, extending over any amount of surface; and it may be that the simultaneous appearance of dense fogs at times over the whole country, and even extending far out to sea, may be attributable. Till the present time, I have never been able to account at all for the production of such extensive fogs.

A useful inference may be drawn from the fact of hot and cold currents of air of different velocities and extent existing at the same time, in contact with each other. Such a state is but a struggle between forces, either of which may preponderate at any moment; and to this cause may be attributed, with high probability, the all but unaccountable changes that so suddenly take place at times during winter, and clearly indicates that how warm soever the weather may be at this season of the year, the warm current of air may be deflected at any moment, and give place to the then dominant cold current, for which we should at all times be prepared.

It deserves consideration, whether the secular increase in the temperature of the air in England is not due to these anti-trade winds; whether, in fact, the currents of air which constitute the equatorial streams of England have not, during the present century, continually been increasing in strength and duration, and the continuation of the increase set in a hundred years ago probably may be greatly dependent on the corresponding change of force of the trade-winds themselves.

Respecting the results of the researches connected with the varying amount of water in the air, at different elevations, it may be the most convenient mode to express in the terms of humidity of the air, considering that the whole amount possible at the then temperature be represented by 100, and determining how many such parts were really present—the more or less dryness of the air, at the different elevations, will thus be made apparent: 100 showing complete wetness, there being present then all possible, the number 50 will show that one-half only of the quantity of water required for saturation was really present, and so on, extreme dryness being shown by very small numbers.

Thus treated, when the sky was cloudy, it was found that on the ground the degree of humidity was 74; increased to

78 at 3,000 feet; decreased to 73 at 6,000 feet, and then gradually to 22 at 21,000 feet. The law of moisture shown in cloudy states of the sky, was therefore a slight increase from the earth, to 3,000 feet high; then a slight decrease to 6,000 feet, the degree of humidity at this elevation being nearly of the same value as on the ground—from 6,000 to 7,000 feet there was a large decrease, and then an almost uniform decrease to 11,000 feet.

On the contrary, with a clear sky, on the ground the number found was 59, increasing to 71 at 3,000 and 4,000 feet; then decreased to 50 at 9,000 feet high; and much smaller on ascending higher, to 16 only at 23,000 feet.

The law of moisture here shown, is a slight increase from the ground to 1,000 feet high, a considerable increase between 1,000 and 2,000 feet; a nearly constant degree of humidity from 2,000 to 5,000 feet, and then a gradual decrease to 12,000 feet. At greater heights the air is very dry.

By comparing the results as found from the two states of the sky together, the degree of humidity of the air, up to 1,000 feet, was 15 less with a clear sky than with one covered by clouds; from 2,000 to 5,000 feet it is from four to six less; at 6,000 feet the air with a clear sky is much dryer than at 5,000 feet, but with a cloudy sky it is nearly of the same degree of humidity, so that the difference between the two states is large, amounting to no less than 11. Above 12,000 feet the air, with clear skies, generally becomes very dry, but with cloudy skies frequently becomes more humid, as was to be expected from the presence of clouds at the height of three and four miles.

In both states of the sky at heights exceeding four and five miles the air becomes very dry—the amount of water present being very small indeed; but at the highest elevations I have been, there has always been some water present—I never found the air free from water. At the same elevations the results of experiments on different days were found to be very different; and on the same day water was found to be very differently distributed, there having been met with several successive layers of dry and wet air placed one above the other.

We do not profess in this article to go into minute details regarding all the subjects of research, because our space is limited, and therefore pass several of the objects of inquiry to one of high interest. In the observations made on solar radiation, the sun is the great source of light and heat, and no observations ever had been made on the effects which the sun produces on blackened-bulb thermometers, freely exposed to his influence when beyond the influence of the earth.

The first instruments used for this investigation were thermometers as delicate as those screened from the sun, usually located near to the dry-bulb thermometer, but readily removed to any other position within the sun's influence. It was soon found that the excess of readings was very small; and at the height of five miles high, with a brighter sun than on the earth, the difference, if any, was very small indeed; at the heights of 4 miles, 3 miles, 2 miles, the difference became larger, and increased on approaching the earth.

Having advanced thus far in the inquiry, with results differing a good deal from those expected, it became a matter of considerable importance in reference to our knowledge in this respect, and as possibly leading to some information which might tend to some quality in the heat-rays, to confirm these results by the use of other instruments; for it was just possible that the small projecting bulb of a thermometer, kept free from all objects to reflect or conduct heat to it, might receive them from the sun, and by the quick and constant motion of the balloon, might at once part with them again to the cold air in immediate contact with the bulb. Another and similar thermometer, enclosed in a vacuum tube, was used, the bulb being surrounded by a large glass globe, admitting the heat to pass directly to the bulb, but parting with none to the surrounding air; the results by the use of this instrument seemed to confirm those previously found.

These researches led to the use of Herschel's actinometer, shown at the extreme right hand in the plate. It is an awkward instrument in a balloon, and somewhat difficult to use, but the views then opening to me, and of which I shall presently speak, indicating a new link in the chain of our knowledge by which the several members of our solar system are united together, by receiving heat from the sun, in precisely the same manner, and possibly to the same amount, were so important, and this instrument was the only one I knew which could give the necessary information, I resolved to contend with the difficulties and use it in the balloon. The general results from its use are as follows:—That, when on the ground, the number of scale divisions increasing in a minute were between 40 and 50; at the height of three miles, with a deeper blue sky, and a brighter sun, the increase in the same time will be but seven or eight divisions, agreeing with the previous series of experiments.

These remarkable results lead us to new ideas respecting the passage of the heat-rays through space. From them, it would seem as highly probable that the heat-rays from the sun pass through space without loss, and become effective where wanted only, and in proportion to the density of the atmosphere, or the amount of water present, through which they pass; and if so, the proportion of the heat received at Mercury and Venus, Jupiter and Saturn, may be the same as that received at the earth, if the constituents of their atmospheres be the same as that of the earth, and greater if the density be greater; so that the effective solar heat at the superior planets, Jupiter and Saturn, may be greater than at the inferior planets, Venus and Mercury, notwithstanding their far greater distances from the sun.

If this be true, then there will be no need to refer to the law of the decrease of radiant heat, viz., that of the inverse square of the distance, as applying to the temperatures at the different planets, a law which gives to the surface of the sun such an intense heat, far beyond any we have the power of producing, and in such amount, that no theory that I have seen advanced would seem capable to supply the continual demand.

But few of the heat-rays can be used by the earth; yet there must be an unceasing flow of such rays in all directions from the sun into space; not a very large number relatively can be used by all the planets and satellites of our system, and of those which are received at the planets as on the earth, does the earth absorb them all? or what part is radiated and reflected back, and spread again into space? We know that the presence of water in the air checks both these operations, and, as before stated, the air is never free from water up to the highest point that I have been, viz., seven miles. We may also ask, what becomes of the heat-rays which meet with no constituent matter to generate heat? Where do they go? Do they ever stop? They are not lost, we may feel certain. These and other questions press on us, but with our present knowledge we cannot answer them.

Let us now turn to another investigation still connected with the sun—one of absorbing interest, one promising to tell us something about the constituents of the sun itself. The spectroscope directed to the sun, as is now well known, shows the solar spectrum crossed by dark lines. Some observers attribute some of these lines to our atmosphere; and it became a subject of inquiry of deep interest, to ascend above the lower portion of the atmosphere, and examine the solar spectrum there. This was done with three different spectroscopes: the one which had been used by Professor Piazzi Smyth on the Peak of Teneriffe, belonging to the Astronomer-Royal, and lent by him for these experiments, and two others more convenient for use, and shown in the Plate. The spectrum at all times was found to be brighter and the colours purer than when viewed from the earth; also every line seen from the earth was seen from the balloon, but all better defined and more distinct. The line H, as seen from the earth as nebulous, was seen as made up of fine parallel lines; and generally the spectrum was longer, the lines more numerous, the colours brighter, as seen at a high elevation, than when viewed from the earth.

Let me now briefly refer to a few facts connected with the wind. Firstly, to the currents in the atmosphere. These were found to be very different, and a good deal of information was collected in relation to them, in the twenty-five different ascents: in all it was found that the velocity at the earth's surface was very much less than at high elevations.

The aneroid barometers at first failed, an inch graduated on the dial plate was not an inch, but ultimately the results were as good as those by the mercurial barometers. Of the several hygrometrical instruments, there was very little difference in the results, as found by different instruments, and then the dry- and wet-bulb thermometer is found to be a perfectly trustworthy instrument up to considerable heights. A magnet was found to occupy a little longer time in vibration when high up than on the earth, and therefore magnetism was slightly less in intensity.

The results which have been obtained by the balloon ascents already made, give us a good deal of information upon points in which we could gain none by any other means. Those made upon the decline of temperatures instruct us that we must again investigate the laws of refraction, and they indicate that the laws of refraction good at one place may not be good at another; for we may infer that the state of things existing at different observatories, differing the one from the other so greatly, may require a special determination of the laws of refraction, as applicable to those different states.

The subjects of investigation which may be pursued in balloons are very varied; they are so conducive to the good of science, as to be of the first importance. Still, this country, from its variation in climate, its small extent, and the consequent great uneasiness of mind of the observer, when above the clouds, and out of sight of the earth, not knowing or having any means of judging of the velocity of his motion, being equally insensible whether he is moving at ten miles or seventy miles an hour; and whether or not he is then over the sea; that this country is not well suited for these experiments, and, perhaps, not the best for determining the laws which govern atmospheric changes.

I am in hopes that similar researches will be made in France, and, I hope, in other countries. It is probable that the large plains of the continent, where the weather is more uniform, and the land of greater extent, that the experiments can be made more easily—and, probably, with the further advantage, that general laws may be made more easily apparent.

The importance of such a series can scarcely be overrated; for, whether we regard the atmosphere as the great laboratory of changes which contain the germ of future discoveries, to be applied as they unfold themselves by the chemist, the meteorologist, the physician, the astronomer,—facts physical relative to animal life at different heights; the form of death, which, at certain elevations, is sure to take place; the effect of diminished pressure upon different individuals similarly circumstanced, the comparison of results by mountain travellers with the experience of physical researchers in balloons; the comparison of differently constructed instruments for the same purpose,—these are some of the researches, and some only, to which the balloon traveller may apply himself; all of which are of such great importance, that we do hope that other nations will do their part in these important researches. The amount of information collected in England, in the twenty-five ascents I have made, needs combination; and further balloon experiments in relation to the subjects upon which I have been engaged, had better be deferred till this work is done; so that future experiments should be made in those directions most needing additional facts. Entertaining these views, I consider this series of experiments for the present as completed.

ON THE HIGHEST MAGNIFYING POWERS AND THEIR USES.

BY LIONEL S. BEALE, M.B., F.R.S.,

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IT is scarcely to be wondered at that the utility of very high magnifying powers should have been called in question by many practical men, or that the statements made with reference to their use should have been received with considerable hesitation by experienced observers, who had been in the habit of using, for the most part, powers magnifying under 300 diameters. These views have, it is to be feared, received support from the experience of some who have attempted unsuccessfully to use these high powers. It seems to me that much disappointment in this branch of inquiry may have resulted from the impression that it is only necessary to obtain the instrument and object glasses, and to look through them at a given object, to see all its peculiarities of structure. And when the experiment is made, and nothing confirmatory of the descriptions or delineations given of the particular object observed is seen, doubt is at once cast upon the whole, and no further trouble is taken about the matter. A very few experiments with a simple object and low powers will, however, be quite sufficient to convince any unprejudiced person that success entirely depends upon the manner in which the examination is conducted. There cannot be a greater mistake than to infer that what we cannot see does not exist. It is easy to bring forward many instances in which not a trace of beautiful structure, which requires special methods for its demonstration, can be displayed by the ordinary processes employed.

Minute investigation, like every other kind of real work which it is worth any one's while to prosecute, requires patience, attention, and intelligent practice; and, above all, it is necessary to begin by studying the simplest things in the easiest and simplest manner, and proceed only by degrees to the more complex. While no one would dream of being able to perform any work requiring special skill without any previous thought or practice, many seem to think that the highest magnifying glasses ought to be manageable even by those who have never been in the habit of using moderately high powers. No one should attempt to work with a $\frac{1}{25}$ until he can use a $\frac{1}{12}$ quite readily; and before we touch the $\frac{1}{12}$ we should be thoroughly familiar with the use of the $\frac{1}{4}$. The higher the power the more difficult are all the little manipulations required for arranging the specimen, applying the thin glass, focussing, &c., to say nothing of the greater difficulty of obtaining specimens sufficiently thin and perfectly flattened out, without the slightest derangement of their delicate texture.

Unless, therefore, the observer proceeds on by steps, $\frac{1}{4}$, $\frac{1}{12}$, $\frac{1}{25}$, $\frac{1}{50}$, he will stand little chance of success. But, on the other hand, if the student steadily works on, and takes the requisite precautions in preparing the specimens, he will be surprised at the vast number of new facts he observes with the aid of very high powers; nor can it be doubted that if the magnifying power could be still further increased, yet more important points would be discovered.

During the last quarter of a century great advance has been made in the manufacture of high magnifying powers, and within the last five years glasses have been produced magnifying from 1,500 to 2,500 diameters; and it has been clearly established, not only that the investigation of the structure of the most minute organisms may be greatly advanced by their use, but that the fundamental arrangement of many of the most important tissues of man and the higher animals cannot be demonstrated by object glasses possessing a less degree of magnifying power.

The first fiftieth which was made for me by Messrs. Powell & Lealand was completed and shown at the Microscopical Society on October 12th, 1864. It magnifies nearly 3,000 diameters with the low eye-piece. The same makers produced a sixteenth in the year 1840 and the twenty-sixth in 1860.

I was not aware until a short time since that Mr. Wenham, to whom science is indebted for so very many important improvements in our instruments of observation, was really the first who succeeded in making a $\frac{1}{25}$. Mr. Wenham's glass was completed so long ago as June, 1856, and I have lately had ample opportunity for examining it carefully and studying different objects under it. The principle of its arrangement is somewhat different to that of Powell & Lealand's object glasses. The third lens is single, while in the objective of the last makers it is composed of three. The $\frac{1}{20}$ recently made by Messrs. Smith & Beck was also made upon this plan. The method adopted for correction for the varying thickness of the thin glass is also different in Mr. Wenham's object-glass. The two upper of the three glasses of which the lens consists are movable instead of the lowest one, which is fixed; by which excellent arrangement the correction may be made, while the position of the third lens is unaltered: so that one may watch the specimen while correcting for the thin glass covering the object. This plan is so far superior for practical working to that in ordinary use, that I am surprised it is not invariably adopted in the case of all very high powers. The definition of Mr. Wenham's $\frac{1}{25}$ is excellent, and for the examination of such objects as the navicula I think it possesses advantages.

I now pass on to the consideration of Powell & Lealand's new glass, the fiftieth. This glass defines even better than the twenty-fifth. Plenty of light for illuminating the objects to be examined is obtained by the use of a condenser provided with a thin cap, having an opening not more than the $\frac{1}{30}$ of an inch in diameter. The angular aperture of this glass is not more than 150°, but as is well known many twelfths have been made with a much higher angle $=170°$. The preparation may be covered with the thinnest glass made by Messrs. Chance, of Birmingham, or by mica, and there is plenty of room for focussing to the lower surface of thin specimens, which can alone be examined by high powers as transparent objects.

I would draw attention to these very high powers at this time more particularly, because the facts recently urged in favour of the doctrine of spontaneous generation, lately revived, may be studied with great advantage. Not only are particles, too small to be discerned by a sixteenth, well seen by a twenty-fifth or a fiftieth, but particles too *transparent* to be observed by the twenty-fifth are distinctly demonstrated by the fiftieth. I feel sure that the further careful study, by the aid of these high powers, of the development and increase of some of the lowest organisms, and of the movements which have been seen to occur in connexion with various forms of living matter (Amœba, white blood-corpuscle, young epithelial cells, &c.), will lead to most valuable results bearing upon the much debated question of *vital actions*.

Another very great advantage resulting from the use of the highest powers occurs in minute investigations upon delicate structures which occupy different planes, as is the case in many nervous organs. In studying the distribution of the nerves in some of the peripheral organs of vertebrate and invertebrate animals, very fine fibres can be followed as they lie upon different planes, and their precise relation to other tissues can be accurately determined.

The most delicate constituent nerve-fibres of the plexus in the summit of the papillæ of the frog's tongue (New Observations upon the Minute Anatomy of the Papillæ of the Frog's Tongue, Phil. Trans. for 1864), can be readily traced by the aid of this power. The finest nerve-fibres thus rendered visible are so thin, that in a drawing they would be represented by fine single lines. Near the summit of the papilla there is a very intricate interlacement of nerve-fibres, which, although scarcely brought out by the twenty-fifth, is very clearly demonstrated by the fiftieth. In this object the definition of the fibres, as they ramify in various planes one behind another, is remarkable; and the flat appearance of the specimen, as seen by the twenty-fifth, gives place to that of considerable depth of tissue and perspective. The finest nerve-fibres ramifying in the cornea and in certain forms of connective tissue are beautifully brought out by this power, and their relation to the delicate processes from the connective-tissue corpuscles can be more satisfactorily demonstrated than with the twenty-fifth. The advantage of the fiftieth in such investigations seems mainly due to its remarkable power of penetration.

It should be stated that the specimens of animal tissues which I have subjected to examination by very high powers are mounted in strong syrup, or in the strongest glycerine, according to the process detailed in "How to work with the Microscope," 3rd edition, p. 204. It is perfectly true that no advantage results from examining by the aid of very high powers the tissues of man and the higher animals immersed in water, or in fluids of which water is the chief constituent; nor is it possible to make the specimen sufficiently thin for examination with very high powers if immersed in a limpid fluid. The arrangement of the nerve-fibres I have referred to is not to be demonstrated in tissues immersed in water. The finer branches of the nerves are, in fact, quite invisible until the specimen is well impregnated with a highly refracting fluid. The imperfect methods of preparation usually employed for examining the higher tissues have given rise to a prejudice against the employment of high powers. It cannot be too strongly insisted upon that very high powers are useless to those who have not had considerable practical experience in preparing specimens, and too much thought and care cannot be bestowed upon the process of preparation which the observer has determined to adopt.

I have not referred to the use of very high powers in studying the characters of the Diatomaceæ, because it is a branch of microscopic investigation which I have very little studied. Other observers will probably state very shortly if anything is gained by the use of these high powers in this department.

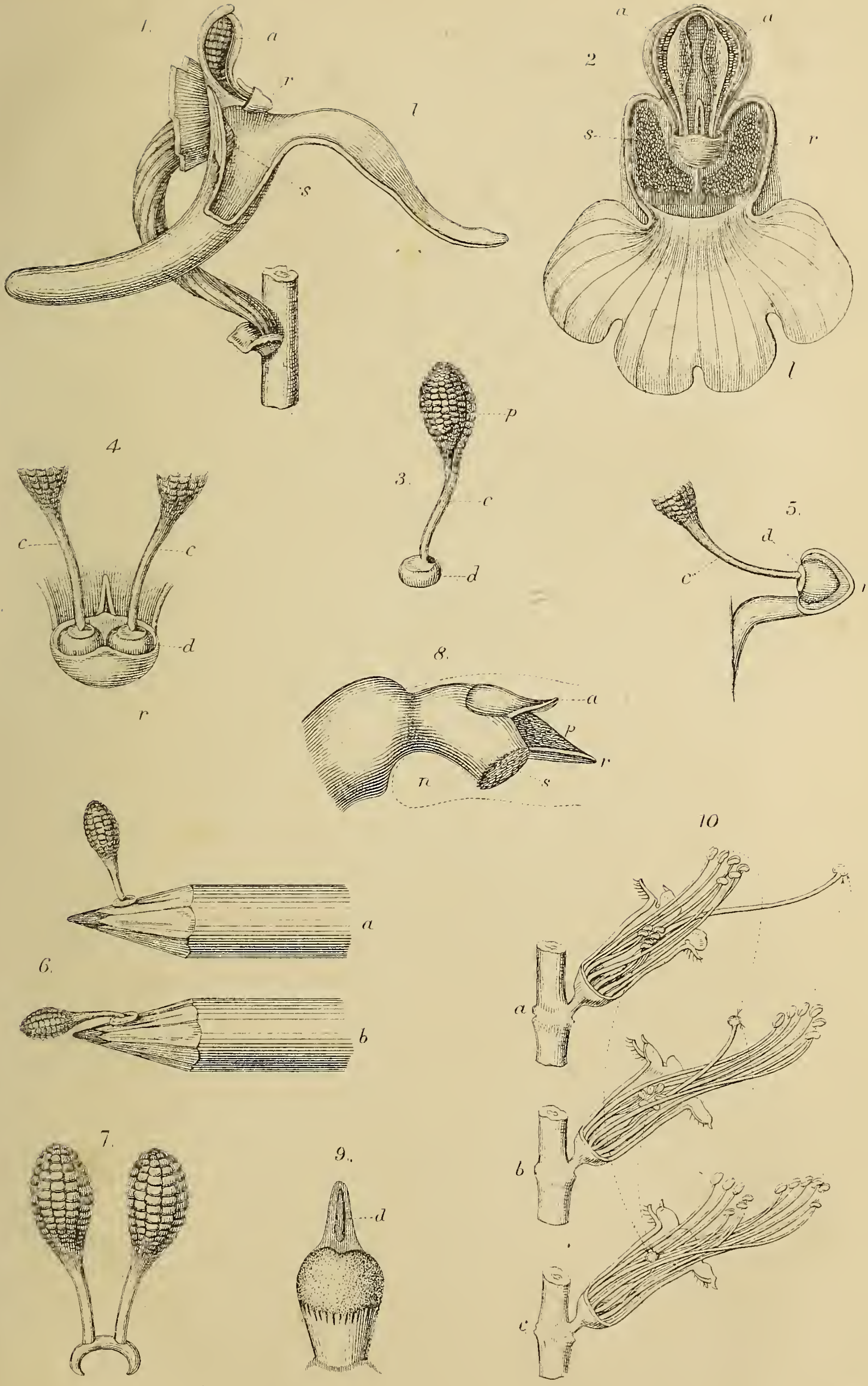
I feel sure that, by improved means in illuminating the objects, many new and important points will be made out by the use of very high magnifying powers. Mr. Brooke has already suggested possible improvements in the condenser, some of which, I believe, he will carry out shortly; and Messrs. Powell & Lealand and several microscopists are now working in the same direction. I feel confident that many new and highly important facts will yet be demonstrated, even in the simplest and best known objects, by improved methods of observation.

DARWIN'S OBSERVATIONS ON THE PHYSIOLOGY OF THE PROCESS OF FERTILIZATION IN PLANTS.

BY M. C. COOKE.

HISTORY affords us examples of philosophic minds, like bright stars illumining dark ages, and darting rays through the long vista of centuries into remote times. Whenever and wherever such lights have broken forth they have determined a point from whence a new era commenced, and created as truly a revolution in thought as more social or political manifestations have ripened into revolutions in action. The "revolution of ideas" is often claimed by the partisans of convulsions which have metamorphosed the Governments of States, but the revolution of ideas emanating from philosophic minds, to which our attention is more particularly directed, is not less positive, but more insinuating; is less rapid, but more certain; and though no less the result of power, it is that of mind, not matter; of brains, not brawny arms. No one can gaze backwards through the history of science during a few centuries, without noticing how certain men, with powerful minds, determined wills, untiring industry, unity of purpose, and clear perception, have given a tone and direction to all thought within the sphere of their labours long after their bodies have mouldered into dust. Compared with the bulk of men eminent in science, such bright particular individuals are not common; but, as compared with other "reformers," if we may use a term often degenerated in its application, in art, religion, literature, politics, such men are not rare. Such a one, though still living and working amongst us, even his opponents will almost admit is Charles Darwin. Dispute every step of his advance, quarrel with every conclusion as they may, in despite of antagonists and antagonism, there is already sufficient evidence to prove that the author of "The Origin of Species" has inaugurated a revolution in thought, which is gradually spreading through the whole scientific world. Whether his conclusions will all be accepted, whether his theory will establish itself as a complete fact, is quite another question, which we are even disposed to doubt, but there is too much positive

Plate XVII.



after Darwin.

W. West lith.

Fertilization.

BRITISH MUSEUM NATURAL HISTORY.

evidence in the direction in which scientific thought has drifted during the past few years to deny that "Darwinism," as it has been termed, has modified and is continuing to modify opinions on all subjects within its scope. Let it not be supposed that because we have admitted so much, because we dare not refuse to recognize this fact, that we are therefore prepared to swear by the book, the whole book, and nothing but the book, or that it is our purpose to champion its author, and vindicate its cause. There are two phases in which we think that Mr. Darwin is to be regarded—as the advocate of a theory, and as a practical worker—it is the latter phase more particularly which concerns us on the present occasion; and that, too, with more especial reference to vegetable forms and functions.

Three years ago, appeared his work on the fertilization of Orchids,* and since then other shorter contributions to Botanical Science. These will serve as the texts for our brief commentary. To understand the direction of his observations, and the deductions therefrom, it will be necessary to indicate the peculiarities of structure in the plants subjected to experiment. These are amongst the most singular and attractive in the vegetable world, not only on account of the extraordinary forms which their flowers assume, but for the structure of their reproductive organs. In ordinary plants the centre of the flower is occupied by the *pistil,* the lower portion of which encloses the *ovary,* and contains the *ovules,* which, after fertilization, swell, mature, and become *seeds;* the ovary is surmounted by a cellular elongated filament, called the *style* (occasionally absent). The upper extremity of the style is clubbed or divided, and bears a viscid surface, known as the *stigma.* All these parts together constitute the *pistil.* Arranged about this organ stand a series of more or less slender erect threads; there may be three, or five, or twenty, according to the plant which produces them. Each of these threads or filaments bears on its summit an elongated yellowish or brownish sac or vesicle, termed the *anther,* enclosing a yellow powder, which, when ripe, ruptures the vesicle or anther, and is dispersed; this is the *pollen.* The whole organ is a *stamen.* When the pollen is shed from the anthers, some of the granules adhere to the sticky surface of the stigma; a kind of germination takes place; long slender tubes emanate from some portion of the surface of the pollen grains, pass downwards through the cellular style into the ovary, enter the ovules at the base or point of attachment of the ovules to the walls of the ovary or its central axis, the fluid contents of the pollen grain then pass down the slender tube into the ovule, and mingle with the fluid in the interior, the *ovules are fertilized,* and proceed gradually to become mature seeds, whilst the pollen tubes wither, as well as the style and stigma, their work having been accomplished. Such, in brief, with various modifications, is the mode of fertilization in the majority of plants. It may be added, that in their young state, the above "essential" or reproductive organs are enclosed and protected by one or two series of over-lapping leaves, and, when thus enclosed, we call the whole a *flower bud.* As the flower bud expands, the outer series of leaves, often of a green colour, and termed the *calyx,* expands first, then the inner, or coloured series, which is the *corolla.* The number of leaves in the calyx and corolla is variable, according to the genus or species of the plant. Sometimes both series are coloured, and sometimes only one series is present. These together constitute the *floral envelopes,* which enclose and protect the reproductive organs during their young and tender state.

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* "On the Various Contrivances by which British and Foreign Orchids are fertilized by Insects."—London : Murray. 1862.

In Orchids the whole structure of the flower departs widely from this type, there are "reproductive organs," and also "floral envelopes," but how these differ from those of ordinary plants we will endeavour to explain. As we do so, let us hope that those who need no such explanation will bear with us patiently, for the benefit of readers who may not be so fortunate as themselves.

About forty species of Orchids have a place in the British Flora, and the majority of these are lovers of chalky soils. In all there is one point of structure in which they agree. The filaments of the stamens, and the style which surmounts the ovary, are fused together into one thick *column,* which occupies the centre of the flower, so that there are no separate and distinct stamens as in other plants. We shall best illustrate this by taking one common species as a type, and, for the present, confine our observations to that species. The Early Orchis (*Orchis mascula*) has a flower with six divisions, arranged in two series; the outer three correspond to the calyx, but, instead of being green, are coloured; the inner series, also of three parts, corresponds to the corolla, and each part may be called a petal; these, of course, are coloured, and are placed alternately with the outer series. One of these petals, that is the lower one, is larger than the rest, and differs in shape; in some species it is very large, and shaped almost like a slipper. This is the *labellum.* This lower petal, or labellum, has a spur, or long pouch, which extends backwards, which, on account of its secreting nectar, so grateful to insects, is called the *nectary.* In fig. 1, all the floral leaves have been removed, except the labellum (*l*) and its nectary (*n*). In fig. 2, a front view of the labellum is shown (l) with the opening to the nectary. All the reproductive organs are combined together into one compound organ, which is the column already referred to. The stigma is seated beneath a projection of the column, and consists of two nearly confluent stigmas (fig. 1, *s*), the surface of which is soft and viscid. The projection above this is a curious adaptation of the upper portion of the column, and is named the *rostellum* (fig. 1, *r*), which supports the pollen masses. Here, again, a vast difference occurs between Orchids and other plants. In most flowers the pollen consists of a fine powder, but in Orchids the grains cohere in masses; often borne upon a stalk or appendage, called the *caudicle.* The pollen-masses, with their appendages of all kinds, are known as *pollinia.* In the present species the anther (figs. 1 and 2 *a*) consists of two cells, separated from each other, each containing a pollen-mass. One of these pollinia removed from its cell, is shown at fig. 3, where *p* is the pollen-mass; *c* the caudicle or appendage; and *d* a *viscid disc,* to which the caudicle is firmly attached. Each pollinium has a similar disc, which is imbedded within the rostellum, as shown at fig. 4. A section through one of these discs, and the rostellum in which it is imbedded, would present the appearance of fig. 5. The two discs, at the base of the caudicles of the two pollen-masses, lie quite unattached within the cup of the rostellum, surrounded by fluid, except at the back, where the discs are each at first firmly adherent to a small portion of the membrane of the rostellum. How are these pollen-masses to be transferred to the viscid stigma lying beneath the projecting rostellum, and thus the ovules become fertilized? To answer this question was one of the aims of Mr. Darwin's work, and to explain it so satisfactorily as he has done, gives evidence of no small earnestness and perseverance, through years of close observation. Let us accept the labellum, or lower petal of the flower, as the landing place of an insect. The bee or butterfly alighting on this platform, thrusts its head into the chamber or cavity, at the back of which lies the stigma, in order to push its proboscis down into the nectary. As the rostellum projects above, it is almost impossible for the head of the insect to enter without touching the rostellum; as it is pushed further, the lip is depressed, and one or both of the viscid discs at the base of the pollinia is sure to become attached to the head of the insect; as this is withdrawn it bears with it one or both of the viscid discs attached to its forehead, together with their caudicles and pollen-masses. Let a pencil or any other object supply the place of the insect, and be thrust in at the mouth of the Orchis, in the direction of the nectary, and it will be found scarce possible to insert it without touching and bending down the lip of the rostellum, and bringing away one of the pollen-masses, attached by its viscid disc, as shown in fig. 6 *a*.

"Now, let us suppose," says Mr. Darwin, "our insect to fly to another flower, or insert the pencil, with the attached pollinium, into the same or into another nectary, by looking at fig. 6 *a*, it will be evident that the firmly attached pollinium will be simply pushed against or into its old position, namely into its anther cell. How, then, can the flower be fertilized? This is effected by a beautiful contrivance; though the viscid surface remains immoveably affixed, the apparently insignificant and minute disc of membrane to which the caudicle adheres, is endowed with a remarkable power of contraction, which causes the pollinium to sweep through about ninety degrees, always in one direction, viz., towards the apex of the proboscis or pencil, in the course, on an average, of thirty seconds. The position of the pollinium after the movement is shown at *b*, fig. 6. Now, after this movement, and interval of time (which would allow the insect to fly to another flower), it will be seen that if the pencil be inserted into the nectary, the thick end of the pollinium will exactly strike the stigmatic surface."

Another beautiful adaption then comes into operation. It has been said that the stigma is viscid. As soon as the mass of pollen touches this viscid surface, some portion adheres, whilst the viscidity is not sufficient to pull away the whole pollinium from the head of the insect, so that it may fly from flower to flower, and fertilize several in succession, until all the pollen is exhausted. The structure of the pouch of the rostellum in which the discs of the pollinia are inserted, is also worthy of observation. When in their natural position the discs are kept moist by the fluid surrounding them in this pouch; but when removed the discs dry rapidly, and lose their power of adhesion in a few minutes. So elastic is this pouch, that when depressed by the contact of a foreign object, it is bent forwards so that the pollinia are easily removed; but as soon as the pressure ceases, the pouch returns to its former position, and thereby economizes the moisture it contains, which would otherwise too speedily evaporate. As a whole, the mechanism by which this and many other orchids are fertilized, is so perfect and beautiful, that the account reads like a fairy tale, or rather, like a new Bridgewater Treatise, in which great theological truths are demonstrated without the aid of Theology.

The next species which offers any considerable variation in structure from the Early Orchis, is the Pyramidal Orchis (*Orchis pyramidalis*). In this species the stigmatic surfaces are two distinct rounded spots, one on each side of the rostellum. Then, again, the rostellum overhangs the entrance to the nectary. The pollinia are not separate, but both pollen-masses are attached by their caudicles to a single visid disc, which, in this instance, is saddle-shaped (fig. 7). Another modification of the mode of fertilization consequently takes place. If the proboscis of a moth, or a bristle, be thrust into the nectary, the pouch is depressed, and the saddle-shaped disc attaches itself to the object introduced; as soon as this object, with the adhering pollinia, is removed, by a rapid movement, consequent on drying, the flaps of the saddle curl around, and tightly embrace the object, so that in nine seconds it becomes firmly secured. As soon as this is accomplished, the pollinia, which, by the by, have necessarily diverged from each other in the movement, sweep downwards and forwards through nearly ninety degrees, as in the former instance. In this position the two ends of the pollinia will be found to have acquired such an adjustment that one of the pollen-masses will strike the surface of the stigma on one side at the same moment that the other pollen-mass touches the surface of the stigma on the other side of the rostellum, and the flower is completely fertilized.

In reference to this species Mr. Darwin remarks :—

> As in no other plant, or indeed in hardly any animal, can adaptations of one part to another, and of the whole to other organized beings widely remote in the scale of nature, be named more perfect than those presented by this orchis, it may be worth while briefly to sum them up. As the flowers are visited both by day and night-flying Lepidoptera, I do not think that it is fanciful to believe that the bright purple tint attracts the day-fliers, and the strong foxy odour the night-fliers. The upper sepal and two upper petals form a hood protecting the anther and stigmatic surfaces from the weather. The labellum is developed into a long nectary in order to attract Lepidoptera, and we shall presently give reasons for suspecting that the nectar is purposely so lodged that it can be sucked only slowly in order to give time for the curious chemical quality of the viscid matter on the under side of the saddle setting hard and dry. He who will insert a fine and flexible bristle into the expanded mouth of the sloping ridges on the labellum will not doubt that they serve as guides, and that they effectually prevent the bristle or proboscis from being inserted obliquely into the nectary. This circumstance is of manifest importance ; for, if the proboscis were inserted obliquely, the saddle-formed disc would become attached obliquely, and, after the compounded movement of the pollinia, they could not strike the two lateral stigmatic surfaces.
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> Then we have the rostellum partially closing the mouth of the nectary, like a trap placed in a run for game ; and the trap so complete and perfect, with its symmetrical lines of rupture forming the saddle-shaped disc above, and the lip of the pouch below ; and, lastly, this lip so easily depressed that the proboscis of a moth could hardly fail to uncover the viscid disc and adhere to it. But if this did fail to occur, the elastic lip would rise again and re-cover and keep damp the viscid surface. We see the viscid matter

within the rostellum attached to the saddle-shaped disc alone, and surrounded by fluid, so that the viscid matter does not set hard till the disc is withdrawn. Then we have the upper surface of the saddle, with its attached caudicles, also kept damp within the bases of the anther-cells, until withdrawn, when the curious clasping movement instantly commences, causing the pollinia to diverge, followed by the movements of depression, which compound movements together are exactly fitted to cause the ends of the two pollinia to strike the two stigmatic surfaces. These stigmatic surfaces are sticky enough not to tear off the whole pollinium from the proboscis of the moth; but, by rupturing the elastic threads, to secure a few packets of pollen, leaving plenty for other flowers. But let it be observed that although the moth probably takes a considerable time to suck the nectar of any one flower, yet the movement of depression in the pollinia does not commence until the pollinia are fairly drawn out of their cells, nor will the movement be completed and the pollinia be fitted to strike the stigmatic surfaces until about half a minute has elapsed, which will give ample time for the moth to fly to another plant, and thus effect a union between two distinct individuals.

We need not advert to the experiments instituted to prove that the agency of insects was essential for the fertilization of all the British species of the genus *Orchis*. We cannot, however, entirely pass the subject of the production of nectar in the nectaries of Orchids, to which our author devoted considerable attention. Having examined several species, and found no signs of nectar either in the nectaries or labellum, although the plants must have existed for enormous periods of time, requiring for each generation insect agency, and possessing special contrivances for that purpose, he still pursued the investigation with faith that the nectaries could not be a sham, or that the plants existed by an organised species of deception.

> As soon as many flowers were open [he says] I began to examine them. For twenty-three consecutive days I looked at them after hot sunshine, after rain, and at all hours. I kept the spikes in water, and examined them at midnight and early in the morning. I irritated the nectaries with a bristle, and exposed them to irritating vapours. I took flowers which had quite lately had their pollinia removed by insects (of which I had independent proof on one occasion by finding within the nectary grains of some foreign pollen), and I took other flowers which from their position on the spike would soon have had their pollinia removed; but the nectary was invariably quite dry.

Convinced that the nectaries of these particular species of Orchids never contained nectar in this country, he next examined the membranes lining them, and was surprised to find that the outer and inner membranes were separated from each other, and contained a quantity of fluid between them; moreover, that the inner membrane was exceedingly delicate; and was led to adopt the hypothesis that here was the nectar of which he was in search, confined in a chamber between the two membranes of the nectary, and that the lax inner membrane might be penetrated by insects, and thus a supply of fluid obtained. Further, that the delay caused by the necessity of first puncturing the membrane, would detain the insect longer than otherwise, and thus unable the discs of the pollinia to become more securely attached to the head or back of the insect before leaving the flowers.

> If this relation [he concludes] on the one hand between the viscid matter requiring some little time to set hard, and the nectar being so lodged that moths are delayed in getting it; and, on the other hand, between the viscid matter being at first as viscid as ever it will become and the nectar lying all ready for rapid suction, be accidental, it is a fortunate accident for the plant. If not accidental, and I cannot believe it to be accidental, what a singular case of adaptation!

A singular exception to the general rule in the Orchids examined, was the Bee Orchis (*Ophrys apifera*), for, in this instance, self-fertilization appears to have been provided for. There are two pouched projections of the rostellum, as in many other species. The caudicles to which the pollen-masses are attached, are very long, thin, and flexible, and not possessed of sufficient rigidity to stand upright. The upper ends are curved forwards, and the masses of pollen directly overhang the stigmatic surface. When the flowers open, the pollen cells rupture, and the masses of pollen soon drop forwards suspended by the slight vibrating caudicle just opposite to the stigma, so that the slightest puff of wind sets them in motion; and as they oscillate, the pollen touches against the viscid stigma, and some grains are left adhering, whereby impregnation is effected.

> It is impossible to doubt that these points of structure and function, which occur in no other British orchid, are specially adapted for self-fertilization.

One other illustration from the British Orchids must be the last to which we can refer in detail. This species is the Ladies' Tresses (*Spiranthes autumnalis*). The long, thin, flat rostellum projects from the summit of the stigma (fig. 8 *r*). The disc is boat-shaped, standing vertically on its stem, imbedded in a fork of the rostellum (fig. 9). This little boat is filled with a thick adhesive fluid, which turns brown, and becomes hard on exposure to the air; the membrane of the rostellum folds over the boat, and covers it like a deck. A longitudinal furrow extends over the middle of the boat, which splits through its whole length on being touched gently with a needle, and a little adhesive fluid exudes. After this splitting, the boat becomes free, and attaching itself to whatever has caused the fissure of the membrane, is withdrawn with its adherent pollen-masses. The stigma lies beneath the rostellum, with a projecting sloping surface; its lower edge fringed with hairs.

The tubular flowers of this species are arranged in a spike, each flower standing out horizontally. The labellum is furnished at the base with two globular processes, in which an abundance of nectar is secreted, which falls into a receptacle beneath. The entrance to the nectary beneath the lower margin of the stigma is very contracted. When the flower first opens, there is nectar in the receptacle, but the rostellum and labellum approximate so closely, and so narrow a channel is left, that only a fine bristle could be passed down into the nectary. In a day or two, the labellum retreats further from the rostellum, and a wider channel is opened. This circumstance is important to the fertilization of the species.

Most Orchids have their flowers open for some time before being visited by insects, but, in this instance, the boat-shaped disc, with its pollinia, has been found to be removed soon after the expansion of the flower. At this period, the passage to the nectary is so small, that an insect could not thrust down its proboscis, without touching the furrow along the middle of the membrane covering the disc. This touch causes the membrane to split, and the boat-shaped disc is freed; its viscid fluid causes it to adhere longitudinally to the proboscis, and, as the insect flies away, it bears the pollinia with it. Here arises a difficulty:—Since the labellum lies so close to the rostellum, how could the pollinia possibly be conveyed to the stigma? It has been observed, that, after a day or two, the channel is enlarged, and *then* there is no difficulty in the pollen-masses being placed in contiguity with the viscid stigma. From these circumstances, it must be concluded, that the pollen collected from an early-opened flower cannot be transferred to its own stigma, but to the stigma of another flower, which has been open for two or three days. We will again leave Mr. Darwin to explain in his own words:—

> Hence not only the pollen must be carried from one flower to another, as in most Orchids, but a lately expanded flower which has its pollinia in the best state for removal cannot then be fertilized. Generally, old flowers will be fertilized by the pollen of younger flowers, borne, as we shall see, on a separate plant. In conformity with this I observed that the stigmatic surfaces of the older flowers were far more viscid than those of the younger flowers. Nevertheless, a flower which in its early state had not been visited by insects would not necessarily, in its later and more expanded condition, have its pollen wasted; for insects, in inserting and withdrawing their probosces, bow them forwards, and would thus often strike the furrow of the rostellum.

Writing on the faith of other observations, he adds :—

> The bees always alighted at the bottom of the spike, and, crawling spirally up it, sucked one flower after another. I believe humble-bees generally act thus when visiting a dense spike of flowers, as it is most convenient for them—in the same manner as a woodpecker always climbs up a tree in search of insects. This seems a most insignificant observation ; but see the result. In the early morning, when the bee starts on her rounds, let us suppose that she alighted on the summit of the spike : she would surely extract the pollinia from the uppermost and last opened flowers ; but when visiting the next succeeding flower, of which the labellum in all probability would not as yet have moved from the column, the pollen masses would often be brushed off her proboscis and be wasted. But Nature suffers no such waste. The bee goes first to the lowest flower ; and, crawling spirally up the spike, effects nothing on the first spike which she visits till she reaches the upper flowers, then she withdraws the pollinia. She soon flies to another plant, and alighting on the lowest and oldest flower, into which there will be a wide passage from the greater reflexion of the labellum, the pollinia will strike the protuberant stigma. If the stigma of the lowest flower has already been fully fertilized, little or no pollen will be left on its dried surface ; but on the next succeeding flower, of which the stigma is viscid, large sheets of pollen will be left. Then, as soon as the bee arrives near the summit of the spike, she will again withdraw fresh pollinia ; will fly to the low flowers on another plant, and fertilize them ; and thus, as she goes her round and adds to her store of honey, she will continually fertilize fresh flowers and perpetuate the race of our autumnal spiranthes, which will yield honey to future generations of bees.

In pursuing his investigations on the mode of fertilization in Orchids, collateral subjects, of course, received their due share of Mr. Darwin's attention, and the "why and wherefore" of all the eccentricities of Orchid-life were boldly faced with the resolution of penetrating to the depth of the mystery. As might have been expected from such an inquirer, much curious investigation and some ingenious theories resulted, and the latter portion of the volume to which we have alluded deals with the following supplementary topics : The ideal type of structure in Orchids, or, as he terms it, "The Homologies of Orchids," on the gradation of organs, and, finally, the deductions to be made from his observations. Briefly, it may be stated, that he regards the typical Orchis flower as consisting of fifteen parts, arranged in five series of three parts in each, three to the sepals ; three to the petals ; six to the stamens, in two series of three in each ; and three to the pistil. In no Orchis are all these parts developed.

> Can we (he says) feel satisfied by saying that each Orchid was created exactly as we now see it, on a certain "ideal type ;" that the omnipotent Creator, having fixed on one plan for the whole order, did not please to de-

part from this plan; that He therefore made the same organ to perform diverse functions (often of trifling importance compared with their proper function), converted other organs into mere purposeless rudiments, and arranged all as if they had to stand separate, and then made them cohere? Is it not a more simple and intelligible view that all Orchids owe what they have in common to descent from some mono-cotyledonous plant, which, like so many other plants of the same division, possessed fifteen organs, arranged alternately, three within three, in five whorls, and that the now wonderfully changed structure of the flower is due to a long course of slow modification; each modification having been preserved which was useful to each plant during the incessant changes to which the organic and the inorganic world has been exposed?

Our space will only permit us to indicate that whilst deductions are made in favour of the theory of "natural selection," the culminating and special deduction of the work is—that throughout this vast order, containing, probably, about six thousand species, the act of fertilization is almost entirely left to insects; that self-fertilization is a rare event; and that, herein, "Nature tells us, in the most emphatic manner, that she abhors perpetual self-fertilization."

Finally, we must briefly allude to Mr. Darwin's discoveries on the fertilization of the Purple Loosestrife. Until recently it was supposed that the relative lengths and characters of the stamens and pistils were approximately permanent in each vegetable species; that, in a certain plant which had the pistil extending beyond the stamens, it might be predicated that in all the flowers of the same species the pistil would be found longer than the stamens and similar in all other respects. Such, however, is not the case. Plants with two forms were discovered, and, at length, Mr. Darwin announced to the Linnean Society that he had found a plant in which three forms existed; this was the common purple loosestrife, *Lythrum Salicaria*. This, however, is only part of the truth, the whole being still more marvellous. In the three forms, all of which contain male and female organs, there are three distinct female and three sets of male organs or stamens, all differing from each other as much as in ordinarily distinct species; and all three forms must necessarily co-exist for the organization of the species to be perfect.

In the accompanying figures (fig. 10) *a* represents the long-styled, *b* the mid-styled, and *c* the short-styled forms. In the long-styled form the pistil is one-third longer than in the mid-styled form and three times as long as that in the short-styled form. The stamens are twelve in each form, in two sets, of six in each set. In the long-styled form the six longer stamens are shorter than the pistil, but extend beyond the mouth of the corolla; the six shorter stamens do not reach to the mouth of the corolla, but are concealed within it. The pollen, in both sets of stamens, is yellow, and the grains are a little larger in the long than in the short stamens. In size, the seeds of this form were larger than in either of the others, so that five seeds of the long-styled form were equal to six of the mid-styled form and seven of the short-styled form.

In the mid-styled form (*b*), the pistil was shorter than the six long stamens and longer than the six short stamens, but it extended beyond the mouth of the corolla. The six short stamens, as in the long-styled form, did not extend beyond the corolla. The six longer stamens had pink filaments, and corresponded in length with the pistil in the long-styled form, whilst the six long stamens, in the long-styled form, corresponded with the pistil in the mid-styled form. The pollen grains of the long stamens in this form were greenish, whilst those of the short stamens were yellow.

In the short-styled form (*c*), the pistil was very short, not extending to the mouth of the corolla, and in length equalling the set of short stamens in each of the preceding forms. The long stamens were of equal length to the long stamens in the mid-styled form and the pistil in the long-styled form, whilst the short stamens were equal to the long stamens in the long-styled form and the pistil in the mid-styled form. In this form all the stamens extended beyond the mouth of the corolla. The filaments of the longer stamens were pink and the pollen greenish, as in the long stamens of the mid-styled form, whilst in their uncoloured filaments and yellow pollen as well as in length, the six shorter stamens corresponded with the long stamens in the long-styled form. All the pistils and stamens, in all three forms, were bent upwards towards their extremities, in a manner corresponding with their length. Hence it will be observed, that there are three distinct female organs, differing in length, curvature, and in the size of the seed. That there are three kinds of stamens: *short*—with white filaments and yellow pollen; *medium*—with white filaments and yellow pollen; *long*—with pink filaments and greenish pollen.

We cannot enter into the more minute particulars of Mr. Darwin's communication, suffice it to say, that from careful experiment he ascertained what the greatest amount of fertility was produced by the union of pollen borne on filaments of an equal length with the pistils fertilized; that is, from the shortest stamens with the shortest pistil, from the longest stamens with the longest pistil, and from the medium stamens with the medium pistil. In all three forms the female organ was but feebly, if at all, influenced by the two kinds of pollen produced in the same flower. So that of eighteen possible unions or crossings between stamens and pistils in the three forms, six were fertile, and twelve, more or less, barren. It is clear, therefore, that for a flower to produce its maximum of good seed it is absolutely essential that the pistil of one flower should be fertilized by the pollen from another, and that unless so crossed little or no good seed is produced. By what agency is this intercrossing effected? The same reply which Mr. Darwin has furnished in respect to Orchids he again gives for the purple loosestrife, namely, the intervention of insects.

> Insects are necessary for the fertilization of this Lythrum. During two years I kept two plants of each form protected, and in the autumn they presented a remarkable contrast in appearance with the adjoining uncovered plants, which were densely covered with capsules. In 1863 a protected long-styled plant produced only five poor capsules; two mid-styled plants produced the same number; and two short-styled plants between them produced only one. These capsules contained very few seed; yet the plants were fully productive when artificially fertilized under the net. In a state of nature the flowers are incessantly visited for their nectar by hive- and humble-bees, and various diptera.

We cannot enter into the details of the mode by which this fertilization is conducted, or how the different points in structure are adapted for the perfect fertilization of the plant, whence our author justifies himself in the conclusion that—

> insects, and chiefly bees, act both as general carriers of pollen, and as special carriers of the right kind.

A brief sketch, like the present, cannot do justice to the claims of any author like Mr. Darwin to be regarded as the great stimulator of inquiry and research in a given direction; but we think it will be admitted that no one has done so much of late years for vegetable physiology, and certainly no one has exercised so great an influence upon the current of thought and investigation on the mysteries of species and variation.

EXPLANATION OF PLATE.

Fig. 1. Section of flower of *Orchis mascula*, with floral leaves removed—*l*, labellum; *n*, nectary; *s*, stigma; *r*, rostellum; *a*, anther.

Fig. 2. Front view of the same flower—letters answering to the same parts.

Fig. 3. Pollinium, removed from its cell—*p*, pollen mass; *c*, caudicle; *d*, viscid disc.

Fig. 4. Rostellum, with discs embedded therein and lip depressed—*c*, caudicles; *r*, rostellum; *d*, viscid discs.

Fig. 5. Section of Rostellum and enclosed discs—*r*, rostellum; *d*, disc; *c*, caudicle.

Fig. 6. Pencil, with Pollinium attached—*a*, when first removed; *b*, after depression.

Fig. 7. Saddle-shaped Disc of *Orchis pyramidalis*, with pollinia.

Fig. 8. Section of flower of *Spiranthes autumnalis*—the dotted lines indicate the position of the labellum and upper petal.

Fig. 9. Front view of the Stigma and of the Rostellum with embedded disc—*d*.

Fig. 10. Sections of flowers of *Lythrum salicaria*—*a*, long-styled form; *b*, mid-styled form; *c*, short-styled form.

WHAT IS A TONIC?

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THE most obvious reply to the question, What is a tonic? is,—It is something which gives *tone* to the body. Unless, however, we know what is meant by "tone," we are none the wiser for such a reply. What, then, is "tone"* in a living being? In its full signification, it is that elastic firmness which belongs to the soft parts of the body of a person in vigorous health;—well seen, for instance, in the plump cheek of a robust child.† In a special sense, tone has been used to signify the state of a healthy muscle, when not producing motion, this being a state of strong tension—that is, that of an elastic body under a strain, through some resistance offered to its assuming a condition of equilibrium among its particles. Why "tone" is thus often limited in its use to the condition of the muscular parts of the body is soon explained. The muscles of a healthy living being are always "on the stretch," or ready to contract when it is allowed to them, either by the approach of the points of their attachments, or by their severance from these, intentionally or accidentally effected; and this, too, always in a much more marked manner than do any other structures of the body. Indeed, further than this, it is not to be doubted that much of the tension of some of these other structures is exhibited only because of their connection with, or contiguity to muscular organs. In considering, however, the nature of tonics, tone must generally be understood in its wider physiological sense.

A state of tone is usually indicative of health and vigour of body, just as that of relaxation and flabbiness is indicative of disease, degeneracy, or loss of vigour. We have just remarked that much of the tone or tension of parts depends upon a *tonic* condition of the muscles; but all the soft structures of the body, including muscle, are put, or liable to be put, in a state of tone by other means. All parts of the body are packed closely together, and bound up by the skin and other more or less unyielding membranes, having many points of adhesion to each other and to the bony framework. Consequently, when a soft part increases in bulk or diminishes, it causes, in the respective cases, a strained or a relaxed condition of these membranes, and increased or diminished pressure upon adjacent parts. Variation in the bulk of an organ is to be referred partly to an alteration in the quantity of fluids retained in it, and partly to an alteration in the quantity of its solid substance. Variation in bulk due to the first cause is well seen when cold or exceeding mental depression causes the blood to leave the superficial parts, in the altered volume and tension of the facial members and of the fingers. The disappearance of much of the blood from these organs is quite evident in these cases, and the features become "pinched" and collapsed, and the fingers shrunken, so as even to allow rings to fall off them which ordinarily fit on them closely. Such great but temporary variations in the distension of parts by fluids have, however, little to do with our present subject, and are only adduced as illustrations. But it is found that a state of healthy functional activity in an organ always gives it an increased fulness from the larger quantity of fluids which then permeate it, thus giving it the degree of tone characteristic of health. Variation in bulk, and therefore tension, through change in the quantity of tissue-substance in an organ, is very important, because on this quantity greatly depends the extent of its contractile power, and of the cohesion of its parts. The structures of the body, more particularly in its soft parts, are constantly changing in the matter of which they are composed, the present matter altering in nature, is being thrown off as waste, in place of which new matter is being taken up from the blood. These processes of "waste" and "repair" are usually balanced in their effects. But, a fact familiar to every one, parts of the body and the body itself are liable, even of a person not considered ill, to variations in their fulness and weight from many causes, such as differences in the mode of living, in the amount and nature of exercise taken in the degree of quietness or anxiety of mind, &c. But in many diseases this variation becomes more strikingly noticeable. The disease may be such as to unfit the organism to take due nourishment, or, to prevent further mischief from the disease, it may be necessary to lessen the quantity and nutritive value of the diet ordinarily taken; in either case, while *waste* is necessarily going on, *repair* is imperfect or wanting; and thus parts naturally firm and elastic with fulness of structure bound up in them become lax and flaccid from the uncompensated loss of their substance. Parts, too, of the body, particularly muscles, grow less in bulk and compactness when kept inactive, as they so often are during disease, and consequently cease to distend the membranes which enclose them. In cases of favourable recovery from long and exhausting illness, effects of an opposite kind are as strikingly observed, the increase in quantity of the tissues, and consequent plumping up and distension of parts relaxed and yielding.

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* τόνος, strain, tension.

† If a gash be made in the living body, the edges of the wound will retract, causing it to gape, thus demonstrating in a simple manner that the flesh of the living body is in a state of tension. In the dead body this state has to a great extent disappeared; consequently, when gashed, the incision does not gape.

The tone of the body, then, is the general firmness and elasticity of its parts, and that full contractile power in its muscles which we find in them in a condition of high vigour and active performance of function. This condition being a characteristic of health, to give *tone* to the body is almost identical with giving health to it,—giving it those powers it has lost during a course of disease. Let us, then, next consider, so far as concerns us, the nature and causes of recovery to health, in order that we may better understand the part which we look to tonics to play.

Our bodies are usually in a state of health under the combined action of the circumstances to which they are ordinarily submitted. If, now, some of these circumstances undergo change, ill-health results, as we see, for instance, in the effects of food imperfect in quality or quantity, of over-work of mind or body, of the unwholesome atmosphere and scanty light which pervade so many of the dwellings of the poor in our large cities, or of many other modifications of the normal circumstances of life sufficiently obvious. When, however, the combination of the circumstances bearing upon our bodies has been for a time such as to induce bad health, but is now replaced by that which is suited to the maintenance of good health in a body already healthy, it is found that, in most cases, the bad state of health gives place more or less rapidly to a more healthy state. Why it does so may be thus accounted for. The common state of the body, that of health, is one which has been determined by the operation of the ordinary circumstances of life continued from its origin, and one, therefore, which is a true expression of the effects of such circumstances, or, as we usually say of it, it is the *natural* state. On the other hand, any one of the states of ill-health in the body has been induced by an unusual combination of circumstances; and since it is more or less dependent upon such a combination for its preservation, the known instability of any state of ill-health, as a condition of the body, is a natural consequence of the uncertain continuance of circumstances which are not usual in the common course of things. When, then, the body is again under the influence of normal circumstances only, since its particular state of ill-health wants now its maintaining cause, this state must give way to others, and according to the degree of essential deviation from a healthy condition which the body has undergone, it may be supposed, will be its fitness for reassuming, through a series of transitions, the state which ordinary circumstances induce and maintain—the *natural or healthy* state. Such seems to us to be the rational interpretation of the well-known *tendency* of the body *to get well* spontaneously, as it were.

However, the tendency to get well has long been ascribed to a kind spirit, akin to those who once were thought to govern every other impressive natural phenomenon—to a spirit yclept "*Vis Medicatrix Naturæ.*" Is a man wounded—it wisely excites such actions of his body as are suited for healing up the wound; is his blood infected with poisonous matters, it incites the system to excessive discharges with the purpose of getting rid of them—in a word, is he ill, this kind spirit is actively at work in restoring him to health. Although a production of nature, if, indeed, not a part of the goddess herself, it is a very imperfect production; it does its best, but it often fails, often makes mistakes, only half does its work sometimes, and needs assistance. Such is literally "the curative power of nature," as its character is to be made out from the medical writings of many authors; and such is the supposed cause of our getting well either without physic, or else with its assistance. It is a kind and attentive guardian; but its will to do right far exceeds its knowledge and power. But we must leave it to the praise and admiration of a certain few who are more gifted with faith than ourselves, to treat of recovery of health under medicinal influence.

Of the many ways in which the employment of medicines may aid in restoring health, it is not actually necessary to our present subject to say anything, except of that one in which medicines aid in giving tone to the body; nor could this be done with advantage without a most undue infringement on our space. In most diseases there are only one or two materially injured parts, the unhealthy condition of the rest of the body having arisen in some way from these, and much of the ill-health which remains after the material disease has been removed or much lessened is due to the interference with the proper nutrition of most parts of the body, which, has occurred during the illness. Perhaps food could not be digested, or be sufficiently prepared for the purposes of nutrition; or the blood received abnormal matters into it, or was not duly deprived of waste matters, either of which interfered with nutrition; or certain organs were left in a state of inactivity unnatural to them; but whatever it may have been, weakness and loss of substance generally tell plainly enough, that the disease and its attendant circumstances have prevented the nutrition necessary to the preservation of tone and vigour being carried on. Now from the wonderful co-ordination of the different parts of the system through which the exercise of the function of one influences that of others, this general debility, which commonly results from disease, often disappears but slowly. Thus, if the muscles of locomotion are so weak as to make their exercise painful, the advantages of walking to the system generally are lost to it. Now that medicine which, without removing any cause of disease, aids the ordinary conditions of health in recovering the body from a state of debility, and therefore of *diminished tone,* is a *tonic.* Other medicines than tonics may serve to remove debility when they can remove certain causes of it. Thus in those who, with feeble digestive powers, partake freely of rich and generous food, the blood and secretions become depraved, that is, charged with matters not fully suited for the wants of the system. These cases, which are extremely common, are attended with feelings of lassitude and debility such as are not to be removed by tonics, as is usually discovered by the sufferer, who, somehow, usually undertakes his own treatment by swallowing tonics before he seeks skilled advice. In such cases, alteratives and aperients, conjoined with modified diet, will serve to remove the debility without, or sometimes advantageously with, the assistance of tonics.

The class of medicines ranked as tonics is a striking example of the difficulty which writers on classification of medicines seem to experience in deciding what characters are to be selected to distinguish one class from another. If it be asked is a glass of wine, or a tablespoonful of cod-liver oil, or a few grains of some medicinal preparation of iron, a tonic, a stimulant, or a food, the answer must be it is all three, for it gives strength and tone, it causes vital actions, it supplies wherewith to nourish the body, that is to add material to the organism. We shall now take up this matter with a view of further elucidating the nature of a tonic, and, for this purpose, lay before our readers the relations of tonic, stimulant, and nutrient agents to each other. And, firstly, we shall treat of the relations of food and stimulants, so far as these bear upon those of either to tonics.

Food serves two ends,—the one that of supplying substances in suitable form, from which our organisms may derive the materials necessary to make good the waste of tissue always going on in living matter; the other, that of causing vital actions. That it serves the former is universally admitted, but that it serves the latter purpose is not generally considered,—at least, that it does seems to be disregarded. We shall, therefore, here direct our readers' attention to this point.

Light entering the eye produces the sensation of vision—*it causes a vital action :* the prick of a pin on a sleeping person causes pain, the retraction of his body from the source of injury, his waking up, and probably outcry—*it causes vital actions :* the genial warmth of a fire causes a sensation of comfort—*it causes a vital action.* Now just in like manner to these does *food* cause vital actions. It removes the sensations of hunger and weariness, it produces pleasurable feelings of comfort through the system, and a feeling of vigour, or power of doing things; it affects the mind, so as to make things look brighter in prospect, awaken kindly emotions, and allay irritability of temper. It will often banish pain, and bring sleep to the sleepless, and to those in other ways ill who can take it and digest it properly, it will produce various effects in the form of alleviations of symptoms of the disease.

Now the production of vital actions by a food cannot be the result of its other property, that of giving material to the system. For to afford matter wherewith to nourish the body is *to give* to the body an additional *source of power* to perform its actions—to walk, to hold, to see, to feel:—while to produce such actions is *to cause* the body *to expend its power;* an effect, therefore, totally distinct in kind from the former.

Any substance which causes a vital action in the body is said to stimulate or excite. We may, therefore, say that ordinary food both *nourishes* and *stimulates.* Now among the articles of food we use, we always partake of some in large quantity, when compared with that in which we do others. Other facts being in accordance with these, we are led to deduce from them that those articles of which we require large quantities are those serving principally to nourish the body, and that those taken in small quantities are of themselves unimportant, and possibly, even, useless, for this purpose. Then, as regards stimulation, we find that this has no proportion in its intensity to the nutrition which is, or can be supposed to be, effected. Thus we find that mustard, pepper, and spice, tea, coffee, tobacco, and opium, all of which are taken in small quantities compared with those of meat, bread, and potatoes, and even in minute quantities, when the small amount of active principles which are derived from them is considered with that from the nutritious substances we have cited, have very powerful stimulating effects, in comparison with the necessarily slight nutritive effects they can produce. Now those substances which are remarkable for their stimulating effects have received generally the name of *stimulants;* in consequence of which the great mistake, so very common, has been caused, of looking upon other articles of food as *nutrients only,* through which very unsatisfactory ideas have been held, and are held still, of the relative nature of foods and stimulants. The conclusion at which we must arrive is this, that a substance, medicinal or other, may be both a stimulant and a nutrient, or what many would call a *food;* for a very general definition of food makes it a substance which can nourish the body with its own matter.

We trust that our readers will now be prepared to understand how it is that morphia (the essential ingredient of opium), or a suitable portion of brandy or wine, may act like meat-soup in exciting the powers of life in certain cases, although there can hardly be a doubt in the mind of any one familiar with such matters, that the soup alone supplies to any extent material wherewith to compensate the "waste" going on in the body,—that they will understand that it is because all three agents may serve as *stimulants,* though they may not all be *nutrients.*

We come now to the relations and distinctions which may exist between tonics and food, and tonics and stimulants. To give *tone* is to give power to the body; to *nourish* is also to give power. While, however, the result of either of the two actions,—giving tone and nourishing,—is the same, the mode of giving power to the body is different. For, whereas, when a substance nourishes, it serves itself as material for the repair of the structures of the body—the muscles, and nerves, and glands, and blood,—which are, it is plain, the source of power in the body, a substance, when it is said to give tone, or to be a *tonic,* does not serve as nutriment itself, but it aids the processes of assimilation of nutritive matters by the system,—it helps to cause the taking up by the body of sources of power, as found in nutrients.

The same substance may possess both the properties of a nutrient and of a tonic; it may not only be able to give itself for assimilation into the body, but may also help to cause other substances to be thus taken up as nutrients. Now, with such a substance, just as with those which are both food and stimulants, the practice seems to be to call it a food or a tonic according as the one or other property predominates. For example, cod-liver oil and the various medicinal preparations of iron nourish; but since they possess such very great tonic power they are called tonics rather than foods.

Let us now consider tonics and stimulants together. To stimulate and to give tone, are not only very different actions, but actions essentially opposed in nature. For to give tone is to give strength and power, while, as formerly remarked, to cause the body to do anything, is to cause it to expend some of its power. This must be the case by the law of "conservation of force," which is that force can neither be created nor annihilated by any natural occurrence; and it is also proved to be so by chemico-physiological researches. Since, then, these two actions are opposite in nature, our readers may feel surprised to learn that we are now going to show that, so far from tonic agents being necessarily opposed in their effects to stimulants, the former are such through possessing stimulant properties,—that, in fine, tonics are stimulants. It is easy enough, however, to show this to be so, for it is only paradoxical in appearance. To give strength to the system by causing, or assisting to cause, nutriment to be taken up by it,—the property of a tonic,—can only be done by exciting various vital actions of the system, by which it prepares and assimilates this nutriment; for, of course, we exclude the effects of substances upon each other in the stomach, by which they may be rendered more digestible, as independent of the system, and therefore, in no sense, vital or physiological effects. Thus viewed, then, it becomes evident, that to act as a tonic is so to *stimulate* the system, as that it manifests such of its powers as serve to assimilate those matters fitted for nutritive purposes. Hence our assertion, that a tonic is a stimulant, is correct.

There follows from what we have said, that a tonic, in acting as a stimulant, *causes an expenditure of bodily power*, while that by serving to aid the process of assimilation of nutrient matters by the organism, *it causes an addition of bodily power*. A little consideration, therefore, will be sufficient to convince any one that for a substance to be of use as a tonic, it must act in such a way as to cause the body to receive more power in the shape of substance added to its structures, than it has to expend in the actions which the medicine calls forth in it, by which digestion and nutrition are advanced. Physiology shows that good food when digested and assimilated affords to the system much more power in its own substance than it causes to be spent in making it a part of the organism, in preparing gastric juice and other secretions to act upon it, in working and kneading it in the stomach, and in other processes. And it must be, for a medicine to act as a tonic that it only calls forth those actions aiding assimilation of food to the extent necessary for that purpose. For if it proceeds further than this, it wastes the powers of the body—expends them to no purpose,—and is further liable to cause harm, in consequence of the actions it has developed falling upon matters in and composing the body, so as to unfit them for their purposes. It is well known to the physician, for instance, that tonics employed in full health, or otherwise inappropriately, are not only of no service as such, but frequently cause both exhaustion and irritation, exhibited in feelings of discomfort and distressing excitement.

The fact of the manifestation of the effects of tonics being almost insensible, has been made the grounds for denial by some that they are stimulants at all, although small doses of some stimulants are admitted to be tonics. But if, as we have set forth, medicines acting as tonics do so by stimulating any of the processes of nutrition, the actions they thus excite must naturally be almost insensible, and if they *do not stimulate* the body to actions of value to nutrition, how do they improve the tone and texture of organs? Such a character of tonic stimulation may indeed serve to distinguish it from other forms of stimulation; but then this is implicitly included in that we have given, namely, that tonic stimulation is the aiding assimilation and nutrition, by exciting certain actions. Some substances, like wine in moderate doses, may, in appropriate cases, produce both tonic and other stimulation,—aid nutrition, that is, and cause sensations often grateful by other actions which they excite.

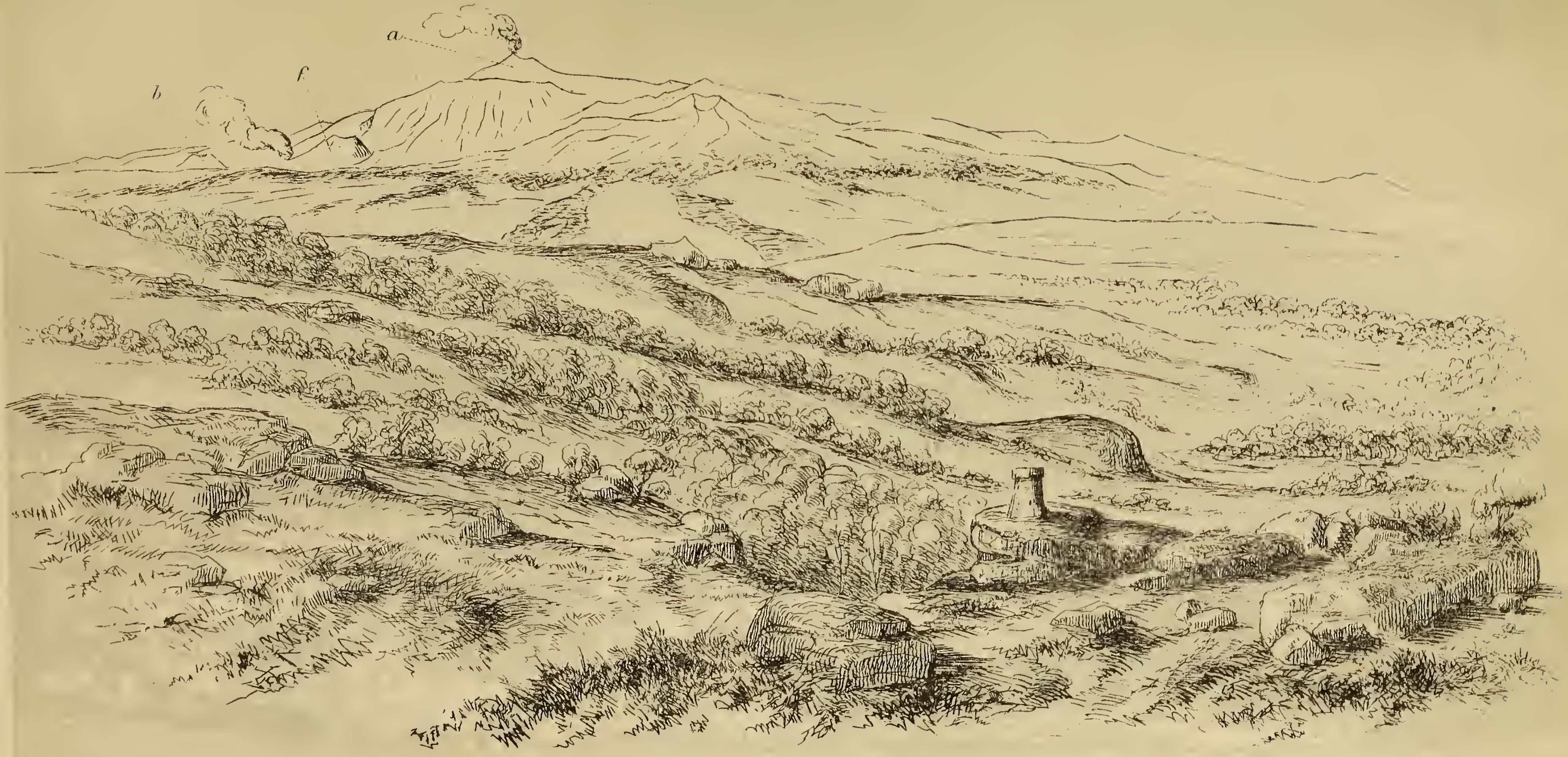
We have now stated the nature of the effects of tonics and their relations to nutrients and stimulants: we trust our reply to "What is a Tonic?" is satisfactory to the minds of our readers. In summary form it is this: A tonic is a substance giving vigour to a debilitated system through causing a more healthy condition of its structures,—not by supplying material for these structures, but by exciting actions in it conducing to a more perfect assimilation of material by it.

We can say very little of what are the actions which tonics excite, beyond this, that they must be some of those which are exhibited during the ordinary nutrition of a healthy organism. During digestion food is submitted to various fluids,—*saliva, gastric juice, bile, pancreatic juice, and intestinal juices,*—which serve to act chemically upon it: to act upon these fluids, or rather their sources, so as to render them more fitted for producing the requisite changes in it, and to cause them to be produced just in the quantities most useful, must be important actions of tonics. To render the blood more suitable for taking up digested food, acting on it, and yielding it up in due form and quantity to the tissues must be another action. An increased degree of organisation of the structure of the alimentary canal, itself a result of tonic influence, must also be an important effect, by producing which tonics may give strength to the system generally.

Practically it is known of medicines having high tonic powers, that they do serve some of these purposes, and of others it is fairly surmised. Preparations of iron undoubtedly raise the quantity of red blood-globules in the system when this is deficient, and, these globules being largely concerned in the nutrition of tissues, ferruginous medicines may thus act as tonics, by improving the state of the blood, whatever other tonic effects they may cause. The almost certain action of cod-liver oil is of a similar kind. It is easily digested and assimilated, and since every tissue-element has fat-globules, as one of its constituents, it must serve nutrition generally, by aiding in forming those elements, such as blood-globules, which serve nutritive purposes. This oil also, in being derived from the liver of an animal, and containing biliary matters, may aid in preparing food for assimilation.

Many substances of value as tonics cause a very bitter taste; indeed, so common is this, that bitterness is generally regarded as an indication of tonic powers. In loss of appetite people usually resort to "bitters." Now, it can hardly be supposed, as some writers seem to imply, that the occurrence of both tonic power and bitterness in so many substances is merely an accidental coincidence. The taste of a substance is proof of the possession by it of certain properties; and so far as the bitterness of different substances is similar, so far must they have properties in common. It is not to be admitted that, in causing taste, substances are passive; they must act upon the tongue, and, in so doing, undergo some change through expending some of their power. Now, the production of a common effect upon the tongue by different substances, is a sufficient evidence that if they act upon the stomach instead, they may cause a common action in it of tonic or other value. For, as we have endeavoured to impress upon our readers, a substance is a tonic because it excites certain actions, or *stimulates*, and therefore the power of exciting bitterness may be a proof of the power possessed to cause a certain tonic effect. Other and injurious properties of a bitter substance may, of course, disqualify it for serving as a tonic; but this does not disprove the proposition that bitterness is significant of tonic power. On the other hand, bitter tonics, while they may owe some of their tonic power to the property by which they excite bitterness, may have other properties to give them in part this power.

Plate XVIII



S. J. Mackie, sc

View of Etna from near the Castle of Castiglione

a. Crater. *b.* Monte Barracca. *f.* Monte Frumento.

BRITISH MUSEUM
NATURAL HISTORY

THE ERUPTION OF ETNA.

BY S. J. MACKIE, F.G.S.

IN one of the most important of recent papers upon the origin of volcanos, one of our best Vulcanists—if such a heathen term may be allowed—comments on the high interest of volcanic phenomena, and on the prevailing ignorance of their causes, in these remarkable words :—

> Now, although the study of the laws of volcanic action is a branch of geology which has not attracted much attention in this country, yet every one will, on consideration, admit that, among all the forces of nature which may be seen in activity on the surface of the earth, the volcano is by far the most striking in its phenomena, and the most directly demonstrative of the character and mode of operation of those (as yet little understood) subterranean agencies by which the crust of our globe has been unquestionably from time to time modified, and was in all probability in a large degree elaborated.

What was here true in Mr. Scrope's remarks in 1859 is true still. We do not yet know either the cause or the source of volcanos. Before, however, we can hope to comprehend the scientific bearings of volcanic phenomena in respect to existing theories, we must briefly understand what those principal theories are. No one would now dream of looking upon the flame and smoke-belching crater of the Sicilian mountain as the ancients did, in their wonderment and affright, as the entrance to hell or Hades ; or of giving full faith to those sublime and poetic notions which they conceived, amidst the rumblings and resoundings of the dreadful district, of the deep-seated smithery of the Cyclops forging, under the fire-god Vulcan, the thunderbolts of Jove. And so we may only use these romantic mythological fantasies as an embellishing vignette to our chapter.

The earliest geologists attributed volcanic action to the ignition of beds of coal, sulphur, and other inflammable materials ; but the first who went any way to practically or experimentally support this view was Lemery, who, in the "Memoirs of the French Academy" for 1700, in order to account for the spontaneous firing of such substances notified certain mixtures of sulphur and clean iron-filings which he had contrived, and which, when buried, and exposed to the humidity of the soil, in a few hours grew warm, raised the ground, emitting sulphurous vapours and flames through the cracks and crevices, sometimes bursting into explosion with a vivid fire, which would continue for some time when the quantity of the materials used had been very large. Breslac "went in" for what we may term the rock-oil notion, imagining that volcanos might arise from masses of petroleum collected in those favourite receptacles of imaginative geologists, underground caverns, and fired through the presence of other substances, such as sulphur and phosphorus, or even spontaneously, as coal mines occasionally are.

Now the main and insuperable difficulty, as Dr. Daubeny very pointedly remarks, attendant on these and all other hypotheses which assumed the combustion of bodies such as those above mentioned, is the absence of the products which constantly arise from such combustion under ordinary circumstances, together with the presence of others which could not in such a case be expected.

And he further well points out that the carbonic acid evolved should be accompanied with unburnt carbon, with carbonic oxide, and so on; as also that sulphuretted hydrogen would not be disengaged in large volumes from a crater where carbonaceous matters were freely burning; and, finally, he urges that water could not be as abundantly present as it evidently sometimes is, without extinguishing the flame of mere carbonaceous combustion, or cooling down the temperature below the fusing point of lava.

When Davy discovered in 1807 the metallic bases of soda, potash, and magnesia, he suggested that masses of pure alkaline metals might exist in the depths of the earth, and give rise—by their ready combination with oxygen and the violence of their combustion—to that intense action required as the prime motor of volcanic eruptions. But then there was, opposed to this idea, the difficulty of Nature's obtaining sufficient quantities in store, or even any quantities at all of such volatile metals. Daubeny, however, supported this doctrine in a modified form in his memorable "Description of Active and Extinct Volcanos;" repeated it in the second edition of that work, in 1848; and, so far as I know, adheres to it still.

There is yet another, the most widely accepted theory, that all volcanos have a common origin in the supposititious molten interior of our globe. The asserted deep-seated location of the volcanic force; the exhibition of volcanic eruptions along long lines extending across large geographical areas; the necessity of a vast amount of heat for converting the mineral lavas into fluidity; have been all regarded as strong presumptions in favour of a universal substratum of "the volcanic fires" *beneath* the solid crust of the earth.

For myself (I may be rash), I do not disguise my heretical disbelief in the still favourite geological hypothesis of a molten core existing within our globe. The contraction of this outer "crust" of our planet, as it slowly parts with heat into space, upon this liquid core, is by many, if not by most modern geologists, regarded as not only the main means of the uplifts and depressions of continental lands, but also as the source of earthquakes and volcanos. Attempts even have been made to associate the latter phenomena with tidal actions produced on this internal molten ocean by lunar influence, as also with alterations in the conditions and barometrical weight of the atmosphere.

Nor are we digressing to this topic without a purpose. There are but these two main theories for accounting for the occurrence of volcanic eruptions—the chemical and the mechanical theories, or that founded on the belief that *chemical energy* can give rise to sufficient heat by its action upon certain constituents of the rock-masses forming the substance of our earth, and that based upon the supposition of a pre-existing universal subterranean source of heat, and which hence regards all volcanic phenomena as the *mechanical effects* of this grand central furnace. Now, it is fair play to speculate either upon or against this terribly hot "infernal region" upon which the mechanical theory is based, because nobody really knows anything about it, and nobody is ever likely to go so far down below to see; and it is also well to state a fact or two against it, because it has had too much prominence, and stands not only greatly but unjustly in the way of a fair consideration of the chemical theory. The most vaunted proof of the existence of an internal molten core within our globe has been the assertion that in deep mines and borings there is found an increase of temperature in the rock-masses of one degree of temperature for every 60 feet of depth. There *is* reason for doubt on this subject; but assuming the data as our modern Plutonists give them, namely, that this world has consolidated by cooling an outer solid sphere or "crust" 800 miles in thickness, around an interior still liquid nucleus, and that as we mine or bore deeper into this solid crust the temperature of the rock-masses does increase at the rate stated; then at 164 miles, only one-fifth of its thickness down in its outer or coolest part, we should have a temperature equal to that of the oxyhydrogen flame, or 14,580° F.

Dr. Miller has shown by the spectral analysis of sunlight that the heat of the sun does not exceed this extent, and, therefore, if these Plutonic facts and fancies be true, we must have within the *solid* crust a heat equal to the actual combustion of the sun itself; and at the full depth of this *solid* skin-crust a temperature of 80,400° F.—utterly incompatible, according to my ideas, with the present rigid and quiescent condition of the earth's surface. Surely, too, if there were such a universal and permanent central heat, the volcanic evolutions of gases and steam and the outflow of lava should be continuous and persistent—the pot should be always boiling and the porridge all alike. Instead of this, the essential character of volcanic action is intermittence, and lavas everywhere differ in composition. If the central heat melted the hypogene or nethermost rocks of the earth's solid crust into lava, as has been supposed *because* the constituents of granitic rocks, for example, and lavas are of the same classes of minerals—namely, mainly silicates of magnesia, alumina, soda and potash; such as hornblende, felspar, augite, &c.—then, in that case, the central heat has had to *re-act* upon portions which, in the cooling of the whole mass of the globe, had become *solidified by loss of caloric*, and this could hardly be the case without an *increase* of the temperature of the supposed interior molten core; and where is this increment of heat in an admittedly gradually cooling globe to come from?

There is only one way of finding out the source of volcanic eruptions—to examine their products, and thence to deduce the manner and mode of their formation. This brings us to the consideration of the chemical theory, for by the chemical analysis of the mineral ejections, and the study of the chemical nature of the gaseous emanations, it must be that we shall arrive some day at the means of making lavas synthetically. Now, all lavas consist in the main of two principal mineral ingredients, hornblende and felspar; the first a silicate of magnesia, the last a compound silicate of alumina and soda, or potash. Augite may be regarded as the same as hornblende, for it has nearly identically the same composition. Iron exists in lavas as the colouring matter, and may have acted as a flux during the melting. Obsidian and pumice have a like composition with felspar. Now, here we certainly have as the bases of these chief lava-minerals, metals capable of violent ignition. In hornblende, the base silicon—highly combustible—in the state of silicic acid, just as it would be *after* combustion, *i.e.*, combined with oxygen (SiO_2). Magnesium has been lately made too familiar for its illuminating power to necessitate any further reference. The combustibility of calcium is well known in the brilliant "lime-light." In felspar we have either a soda or a potash base, and the ignition of sodium and potassium by mere contact with water, or a moist substance, is too common an experiment with popular lecturers to dwell upon. Just let us set side by side the usual compositions of the chief volcanic mineral products :—

	Augite.	Hornblende.	Felspar (Potash)	Albite (Soda Felspar).	Pumice.	Obsidian.
Silica (SiO)	54·15	59·5	65·69	67·99	62·04	74·80
Lime (CaO)	24·74	12·3	1·34	...	1·31	1·96
Magnesia (MgO)	18·22	26·8	...	...	·72	·90
Alumina	...	...	17·97	19·61	16·55	12·40
Potash............	...	...	13·99	...	3·66	6·40
Soda	...	...	1·01	11·12	6·39	(sometimes.)
	&c.	&c.	&c.	&c.	&c.	&c.

In every case the original or combustible base is combined with oxygen.

So far as I know, this branch of inorganic chemistry is not in that state of advance that would permit of any definite scientific deductions being at present obtained from the combinations of the metal bases with the oxygen. Organic chemistry has taught us that organic products are in definite combinations in regular series, and when one link is missing to knowledge, it can be formulated and artificially produced. It seems to me that some such exact knowledge in inorganic chemistry ought to do much in unravelling the mysteries of volcanic formations.

The condition necessary for Sir Humphry Davy's hypothesis is that the pure metallic bases should be situated at a sufficient depth to preclude the access of air, for if air had had access, it would long ago have imparted that oxidation to which volcanic action, if due to them, would be attributable. The great difficulty has been how to account at all for their elimination in a metallic form. I think, however, that the effects of crystallization might be profitably considered in respect to the possibility of metals and other extraneous substances being extruded from crystallized rock-masses, such as quartz and granite; for we know that salt is extruded from sea-water in the process of freezing, and that the great masses of arctic ice, frozen from the ocean, are composed of water perfectly fresh.

Sodium, silicon, potassium, calcium, magnesium, may have been extruded in the crystallization of hypogene rocks, and have formed large and dense beds where the crystallizing operation has been carried on during vast ages, over enormously thick and vast geographical areas. Does not the condition of pure gold and silver veins in quartz rock favour such an idea?

Again, be it the absolute combustion of sodium, potassium, silicon, and magnesium that may be assumed as the cause of volcanic action, or be it the heat generated in some slow modified combustion effected by the decomposition of previously existing compounds and the re-composition of new ones, it still seems to me that the very *mechanical* action of the overflow of lava and the ejection of gases goes far to show that it is *chemical action* of some sort that gives rise to those *mechanical effects.*

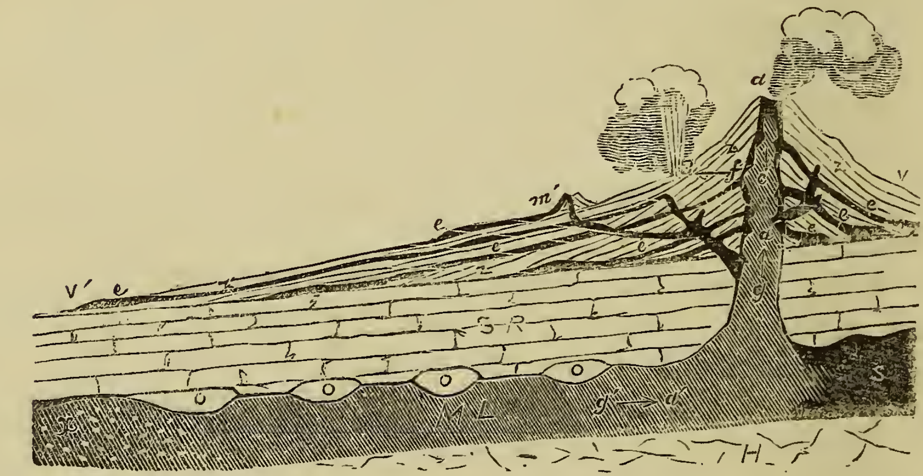


Fig. 1.—Ideal Section of a Volcano.

S R, Solid Stratified and other Rocks; M L, Source of Molten Lava; H, Solid Hypogene Rocks; V′ V, Crater formed of Lava-streams (*e e*) and layers of ashes (*z z*).

If, instead of steam, as in the Geysers, gases were accumulated in pockets of the solid earth-roof (*o*), above the molten lava-source (M L) in the depths of the earth, or in huge bladders (*o*), or even disseminated in innumerable mere bubbles in the substance of the lava-source itself (as at *x*), the continued increasing compression of such gases, by their mere accumulation within a limited space, no matter how large, would in the end give rise to sufficient mechanical force to cause a general flow of the whole lava-mass towards any volcanic chimney or fissure (*g*->*a*) where the pent-up gases might liberate themselves and escape, or where the hot lava, forced up, as in Etna, to 11,000 feet, might overrun the summit (*a*), or, by its weight and downward pressure (*a*->*c*) burst open a new crater (*d*) through the incoherent sides of the cone (V′ V), as in the last eruption which broke out far below the central orifice, near the base of the monticule Frumenta (Fig. 2, F). The gases liberated—whether by easy escape or by violent explosion—the pressure upon the lava-source would be relieved, and all would be quiescent until the consolidation of the lava at places exposed to chilling, as in the crater and where the subterranean lava-source was thin, or the unequal action of the chemical forces leaving unmolten masses in the changing materials caused fresh obstructions, when the gases would again be pent up until they had re-accumulated sufficient power to burst their barriers and release themselves by eruption. Around every existing volcano are burnt-out areas; and distinct from the present foci, often in very distant regions, are regions where volcanic activity has long since become extinct. May not this mean that the action has been taking place along the subterranean out-crop of those intercalated beds of mineral substances whose chemical decomposition and re-formation has given rise to the volcanic force?

We have been led to the present article by the recent eruption of Etna—the largest and most celebrated of European volcanoes. Upon a grand platform, composed of once molten ejectamenta (cinders, scoriæ, and lava), 9,000 feet above the sea (see Plate XVIII.), its principal cone (*a*), towers still another thousand feet, and from the lofty summit (10,874 feet above the sea) of that fiery chimney the eye scans around the "Demon's Vale," and overlooks 900 miles of clouds and outspread scenery beyond. Beneath the snow-capped heights, whence Sicilians, Italians, and Maltese obtain their refreshing summer drinks, are three well-marked climatal zones girdling the mountain's flanks—the desert, the wooded, and the highly cultured bands. In the midst of the highest snow-fields (*x*), the darksome crater (*a*) rises steep, and smoke emitting from every pore—nine miles round at its base (*m d*) and three at its mouth (*s o*)—presenting in its inner funnel a deep unapproachable gulf, out of which, ever and ever, wreaths of heavy sulphurous smoke roll down its barren sides. In one place a rift of snow lies bedded between thick lava-streams, whose own ashes have formed the non-conducting layers that have preserved it from the heat of the molten river which flowed above; and everywhere, in the extensive caverns in the huge and rugged mountain mass, goats take shelter from the storms.

Around the vast base of the whole gigantic pile—some 90 miles in girth—a rich cultivated region extends, from six to eleven miles broad (except upon the north, where it scarcely reaches for a mile) covered with towns, villages, and monasteries, inhabited by more than a hundred thousand living souls, tempted mainly into their insecure proximity with the dangerous mountain by the luxuriant fertility of the soil. With the progress of the day, the deep shadow of the mighty hill—which at sunrise rules a line across the whole Sicilian isle—slowly tracks its way, and silently marks Time's passage hour by hour. Into its eastern side a huge deep gash has been cut, so Lyell says, by the sea, and in the sands of the shore of Giarre, he sees sediments formed of the *débris* of those courses of lava-streams and over-covering layers of ashes that once, during unreckonable ages, were piled where the deep Val del Bove now exists.

In the structure of the mountain everything is vast. The lava-streams of Vesuvius are incomparable with its *coulées*—

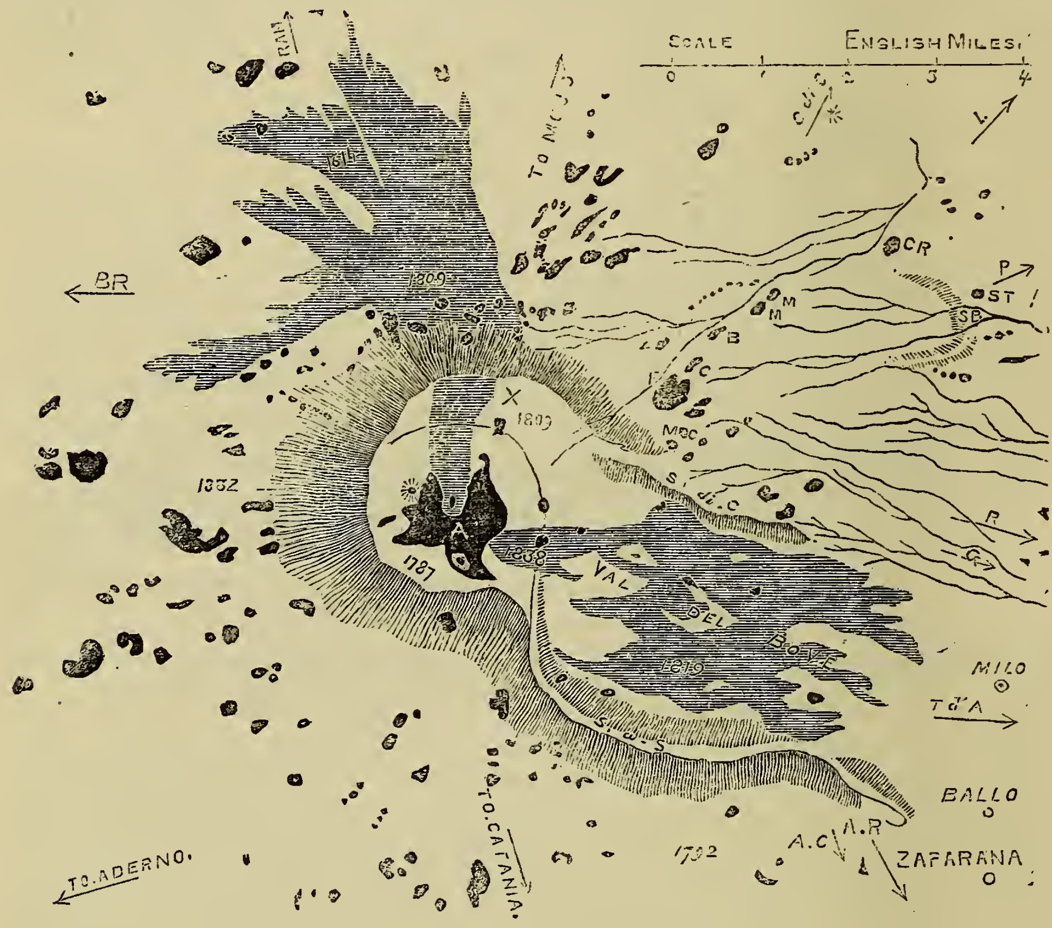


Fig. 2.—Plan of the Elevated Regions of Etna.

A, the Crater; X, Platform of old Crater. The dates 1809, 1792, &c., indicate the main sites of the lavas of those respective dates. The black spots indicate various lateral craters of eruption. The directions of the following principal towns are indicated by the arrows; the distances added are reckoned from the points of the arrows. * C de C, Castiglione, 5 miles; the site whence the View in Plate XVIII. was taken. Mojo, 5 miles. R A N, Randazzo, 4½ miles. L, Linguagrossa, 2 miles. P, Piedimonte, 3 miles. (Annunziata is 3 miles to the south of this.)* R, Riposto, 4½ miles. T d' A, Torre d' Archirafi, 6 miles. A R, Aci-Reale, 7 miles. A C, Aci-Castello, 10 miles. To Catania, 14 miles; and on the same line is Nicolosi, 5 miles. To Aderno, 4½ miles. B R, Bronte, 4 miles. S. d. C, Serra delle Concazze. S. d. S, Serra de Solfizio. F, Monte Frumento. C, Monte Concone. B, Monte Barracca. M C, Monti delle Concazze. M M, the "Two Mountains." C R, Monte Crisimo. S T, Monte Stornello. S B, Serra Buffa.

often 15 to 20 miles in length by 4 or 5 miles in breadth, and 50 to 100 feet in thickness. These lava-streams do not by any means always issue from the great summit crater (*a*) itself, but as commonly, and, indeed, even more frequently, from the base and slopes of the upper quarter; so that around the main central cone are numbers of monticules (Fig. 2, black spots), that have at some time or other formed the orifices for lava-floods.

In a letter I received from Catania, dated 1st June, Mr. Jeans, the British Consul there, informs me that the eruption still continues. His remarks are very correct and most interesting. He says :—

As you are no doubt aware, the eruption broke out on the night of the 31st January during a thunderstorm. The weather for some weeks previously had been unusually warm for the season, and on the night of the 31st December we had a monitory symptom in the shape of a slight shock of earthquake. The exact locality of the eruption is a short distance to the eastward of Monte Frumento, and when I last visited the spot, about six weeks back, there were four distinct craters, forming a long ridge, running in an easterly direction, and composed of lava and scoriæ. The highest portion of this ridge, Lord Somers, who was with me, and who has some experience in observations of the kind, calculated at 1,000 feet. During the first few weeks of the eruption, the different streams of lava proceeding from these craters, and running to the south of Monte Crisimo and Monte Stornello, threatened the villages of Piedimonte and Annunziata to the eastward, and subsequently other streams passing to the north of Monte Crisimo, took the direction of Linguagrossa. To the eastward, after flowing for some weeks, very slowly, the lava reached the old lava-bed known as the "Lave di Scorcia Vacca," when its progress became arrested, probably owing to the loss of fluidity from cooling. The nature of the ground was also unfavourable to its further progress. The northerly streams are running, although very slowly, at the present moment, and the eruption is still going on. It is difficult to say how many lava-streams there are altogether, owing to the fact of their intersecting each other, and forming a sort of delta. On the occasion of my first visit to the scene of the eruption, on the 6th of February, when I viewed it from the summit of Monte Crisimo, there were five distinct craters; subsequently two of them collapsed, or were blown into one; and on the occasion of my second visit, when I viewed it from the edge of a pine forest in the vicinity of Monte Barracca (or as near as it was possible to get with any degree of safety), there were four craters, one of which, that nearest to Monte Frumento, appeared to be almost exhausted, and emitted smoke only, whereas the other three sent forth almost incessantly showers of enormous blocks of scoriæ, amid the most appalling roaring. At present, the lava proceeding from the craters appears to be piling itself up and accumulating round the base of the cone. During the first few days of the eruption, the smoke was charged with black sand, which fell at a very great distance; for instance, on the decks of vessels off Syracuse—a matter of eighty or ninety miles from the craters. On one day this sand fell thickly in the streets of Catania, and presented the appearance of gunpowder. For some time past the great crater has ejected dense volumes of dark smoke, whereas, under ordinary circumstances, when the volcano is in a state of repose, a wreath of light vapour, at times scarcely perceptible, is all that is emitted . . . . The damage caused by the eruption has been trifling, the lava not having reached the highly cultivated region.

Some very excellent observations have also been communicated by M. Fouqué to M. Ste. Claire Deville, the eminent chemist, who has devoted much attention of late years to volcanic gaseous emanations, and who in his turn has rendered them with his own valuable comments to the French Academy. M. Fouqué's description of the principal lava-course conveys an admirable idea of its nature and progress :—

> The ground (he says) over which the lava first spread presents a slope of about 4° or 5°. After having overrun this space, destroying everything in its way, and leaving only some rare islets of vegetation between its courses, the current of lava abutted upon an ancient cone of eruption—Monte Stornello. There it divided itself into two arms—one to the west, which continued its progress with extreme slowness ; the other, on the contrary, passing to the east of that mountain, precipitated itself into the narrow and deep valley of Colla-Vecchio, embanked between Mount Stornello and the chain of the Serra de la Boffa. At this point, the lava precipitated itself from a height of 150 feet, carrying on its surface solidified blocks, which fell with a crashing fracas on the top of the fiery cascade. The valley was soon entirely heaped up, and the current continued its march for a length of about two miles, and finally became arrested on the site of an ancient lava, called the Sciarra de la Scorcia Vacca, at an altitude of some 2,400 feet.

Such is the picture he draws on the 6th February. Since that period the *coulée* of the Scorcia Vacca has entirely ceased to advance. The western branch, on the contrary, has continued its progress, dividing itself into two narrow streams, at an altitude of about 4,000 feet, both situated between Stornello and Crisimo—that nearest to the former M. Fouqué calls the Coulée Antonio; its progress was arrested on the 21st February, at an altitude of above 3,000 feet. The one next Crisimo, which he styles the Coulée Carmelo, made way four days later, and then stopped at an elevation of above 3,500 feet. These two streams, although perfectly stationary at their terminations, still continued, on the 10th March, to make daily slight lateral extensions. The craters of eruption, which he counts at seven, are all situated on a large ellipse, the longest diameter of which is evidently in a line E. 30° N., and are about 150 to 200 feet in height. M. Fouqué has made many interesting observations on the gases and salts; but, as M. Deville differs from some of his conclusions, it is advisable not to introduce those remarks into a popular article.

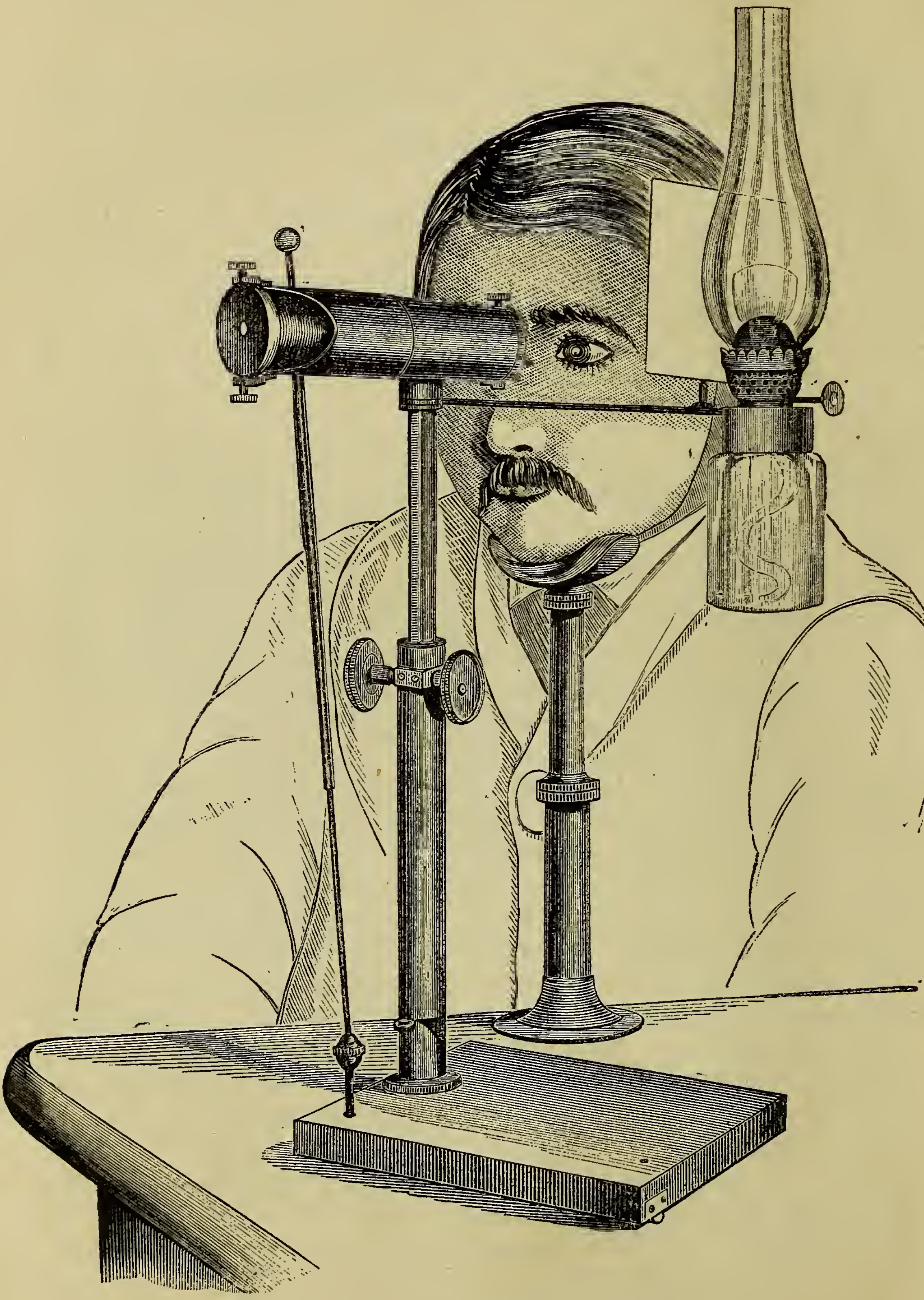
INSIDE THE EYE: THE OPHTHALMOSCOPE AND ITS USES.

BY ERNEST HART,

OPHTHALMIC SURGEON, AND LECTURER ON OPHTHALMIC SURGERY AND MEDICINE AT ST. MARY'S HOSPITAL MEDICAL SCHOOL.

THERE are few spectacles more affecting—and there were few more hopelessly distressing—than that which many have seen, of the blind man, with eyes unaltered in their human aspect of beauty, searching vainly to penetrate the unchangeable darkness of a noon day, bright to others, and replete with the splendour of light and colour. There have always been many of these sufferers from a disease which claims the most profound sympathy, and which seemed bitterly to reproach our science that it could not timely penetrate the mystery of that obscure chamber which lies behind the iris, and had found no means for enabling us to see through the clear but darkened space of the pupil. That reproach, at least, exists in part no longer. Since some few years now we have learnt how to explain the obscurity of the interior of the eye, and by what optical contrivances we can overcome this darkness and look into the depths of the ocular globe; thus inspecting with ease, and quite painlessly to the individual, the lenses and humours of the eye, the nerve of sight and its transparent retinal expansion, and even the vascular tissue which lies behind and surrounds this. This is a great triumph of physical science, and it is no barren triumph. The insight which we gain into the host of affections of the refracting media and deep membranes of the eye has given to our diagnosis and therapeutical treatment of the most obscure forms of disease leading to blindness, a certainty and precision to which we were formerly strangers.

The optical instrument by which we are able to effect this inspection is known by the fitting title of the *Ophthalmoscope* (οφθαλμος, the eye; σκοπεω, I survey). With this instrument, the manner of using it, and its valuable applications, I am necessarily professionally much occupied in daily work; and as the editor of the Popular Science Review has requested me to give some plain account of the matter, I will endeavour to afford an untechnical statement of what the Ophthalmoscope



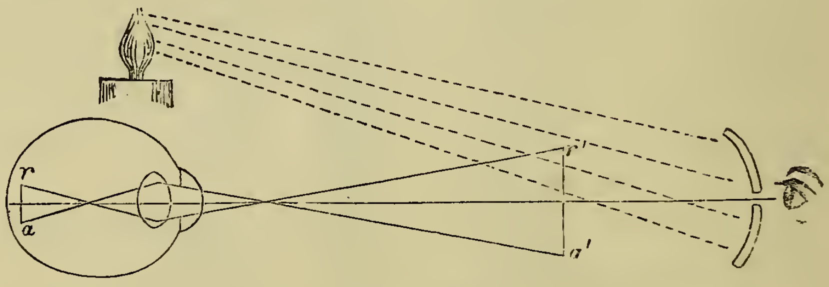
is, and what are some of the most useful results which have been obtained by its use.

Let me first remind the general reader that in the human eye, behind the pupillary aperture of the coloured iris, which presents to the unaided eye of the observer the mere aspect of black darkness, lies first a clear bi-convex *lens;* and behind this, filling the eye, and giving to it the character of a solid ball, a transparent globular mass, known as the *vitreous body* or *humour.* It is into a depression in the front of this that the aforesaid *lens* is fitted, so that the whole space of the eye behind the *iris* is filled by the *lens* and *vitreous body.* The optic nerve, or nerve of sight, which pierces the tunics of the eye at the back and near the centre, spreads out and forms an expanded tunic of nerve-structure which enwraps the vitreous body as far as its most forward edge, where the coloured iris descends in front of it. Enwrapping again this nerve-tunic or *retina,* is a vestment chiefly made of blood-vessels, connected by fine tissue and thickly coated with black pigment, having its own optical uses. This second outer pigmented vascular tunic is *the choroid.* This again is enclosed within the external strong fibrous membrane, which includes and protects all the sclerotic membrane (σκληρος, hard). These are the two humours and three tunics of the eye which can to a greater or less extent be examined during life by the aid of the ophthalmoscope.

They can all be more or less investigated in the living eye by the aid of the ophthalmoscope, because by the aid of this instrument we are able to see through the pupillary space. If one considers what is the reason of the apparent darkness of the pupillary aperture and the chambers of the eye behind it, it is not difficult to gain an idea of the means by which this optical condition may be altered so as to enable us to see where all seems to the unaided vision obscure.

This darkness of the pupillary aperture is attributable partly to obvious causes, such as the natural contraction of the pupil or *iris,* which occurs under light—this contraction limiting the number of rays which can enter the eye. Then that black pigment which lines the iris absorbs a great deal of light; and thus, as in the case of albinos, whose eyes are deficient in pigment, or where the pupil is dilated, either through disease or by artificial agents, these obstacles for seeing into the living eye are removed. But still the main difficulties are not cleared away; and if you take for example an albino animal, such as one of those beautiful little white-furred rabbits, whose rosy eyes look like fiery opals edged with swan's down, and dilate the pupils with atropine, it is still not possible to see clearly the details of the structure within and at the back of the eye.

This is by reason of the structure of the eye as an optical instrument, and because the rays of light in entering and in emerging from it undergo refraction, according to definite laws. The light which penetrates the eye traverses the transparent retina, producing the impression necessary for sight, and is partly absorbed by the black pigment of the choroid; but a great number of the rays are reflected; for here there is no exception to the general rule that some of the rays of light falling upon any substance are always reflected. These rays, in returning, are refracted through the vitreous body and lens, just as they were in entering the eye, with the object then of causing them so to converge as to produce upon the retina a clear and definite image of whatever external object they started from. Similarly, then, on their emergence they are refracted chiefly by the lens and cornea, so as to form an image in the outer air, the emergent rays coinciding in their path with that which they took when entering, and the image formed in the air being conjugated with the retinal image; being formed therefore on the same side, varying with the position of the lens and object, and the accommodation of the eye. Thus, then, to perceive this aërial image, derived from the retinal reflection, the eye of the observer needs to be placed in the axis of the converging rays; but since this is also the axis of the entering rays, he will of necessity in that position cut off those rays altogether of the light proceeding, say, from a lamp, or the source of light opposite to the eye to be illuminated.



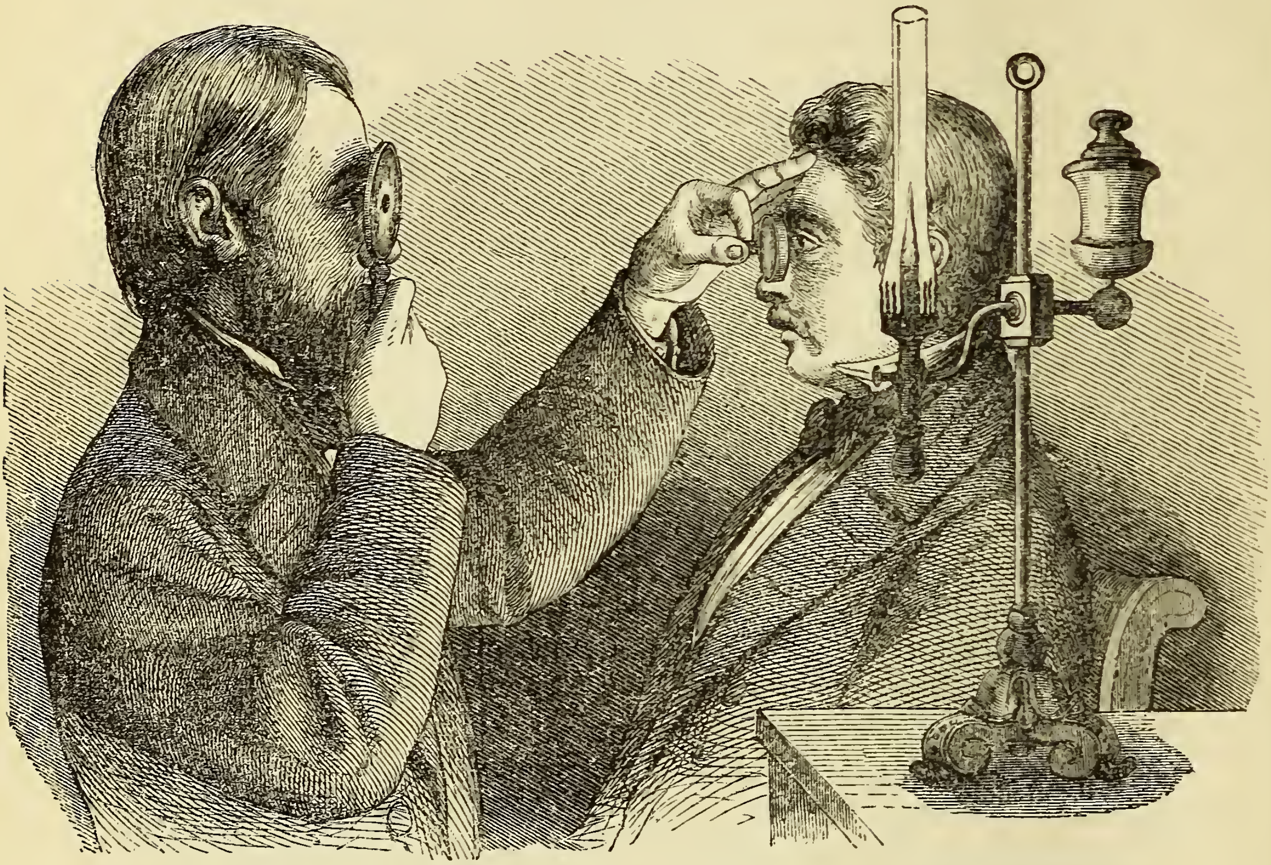
The problem to be solved consists, then, in the simple illumination of the eye to be observed by a source of light so arranged that the eye of the observer can be placed in the axis of the rays entering and emerging without intercepting those rays. This may be most conveniently effected by placing the source of light aside of the eye to be observed, and observing through a pierced concave mirror, which reflects that light into the eye. We can then, by looking through the central aperture of this mirror, place ourself in the path of the entering and emerging rays. The mirror becomes the source of light to the observed eye; the rays which it flashes into the eye emerge in part, and return along the same path, forming the aërial image at a distance and under circumstances regulated by the optical conditions of the eye observed, and within view of the observer who is looking through the mirror. A very simple diagram will suffice to explain this. *r a* is the circle of diffusion of the retina, and the lines indicate how the reflected rays will pass through the media of the eye, and form at r' a' a real enlarged but inverted image of the fundus of the eye. This will be placed at the distance of distinct vision of the subject, and has relation to the accommodation of the eye.

As these are variable quantities, the practice of ophthalmoscopy demands a little address, which habit quickly gives. It is for want of understanding this, and from impatience of these preliminary difficulties, that many have been discouraged at the outset, and have abandoned unwisely the attempt to learn the use of the ophthalmoscope.

The image obtained in the way mentioned is not so distinct as to give that full perception of details which is necessary for scientific and medical purposes. A more defined image is obtained by interposing, for example, a bi-convex lens on the path of the luminous rays emerging from the eye observed. The effect of holding such a lens of short focus before the observed eye whilst examining it with a concave ophthalmoscopic mirror is to cause the rays emerging from the eye to undergo a further refraction. And to modify the actual image which they form, producing one which is smaller, more defined, but still inverted. This is the most simple and one of the most satisfactory methods of exploring the eye with the ophthalmoscope. It is that of the most general and easy application, and I will therefore add a few words to explain how it may most conveniently be practised.

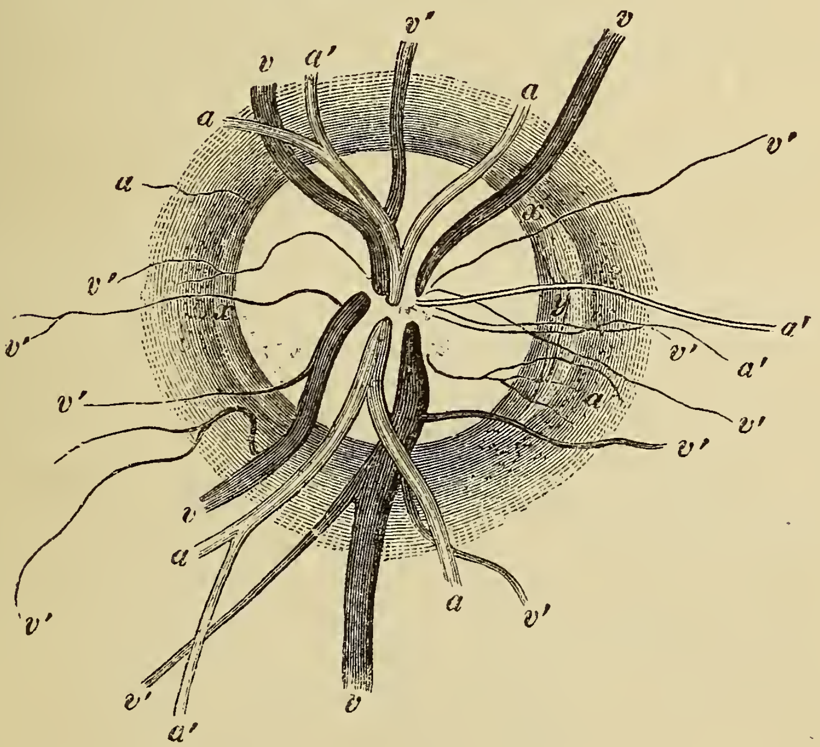
We will suppose that it is the human eye which is to be examined. The room is to be made dark; the person to be seated; a light—the white flame of an oil-lamp or an Argand gas-burner—to be placed near his head, on the side, and at the level of the eye to be observed. The observer takes then the concave mirror in the hand, of the side towards the lamp, and placing it against the front of his eye, so that the upper edge rests against his eyebrow, brings his head to the level of that of the person seated, looks through the central perforation at the eye to be observed, and by a little careful change in the direction of the mirror casts by its aid upon the eye examined the light of the lamp.

He will now perceive that the pupillary aperture is illuminated, and, no longer black, shines with a silvery or reddened light. He takes now the bi-convex lens of short focus, in the hand hitherto free, and places it in front of the examined eye, and at such a distance as to make the focus of the lens coincide with the pupil of that eye—a distance varying from two to three inches. He himself will usually need to be at a distance from twelve to eighteen inches. This is for normal eyes. The slight movements backward and forward necessary to adjust these distances correctly, are effected very easily and precisely after practice; but at first it is a little difficult to avoid changing the direction of the mirror while thus slightly advancing or retiring the head; and this is a point on which it is well to give a warning, for it is a frequent source of discouragement to beginners, who find that at every movement they interfere with the illumination of the eye, and so suffer from a series of little failures at the outset. The first thing, in fact, that every one sees, amounts to little more than a red luminous disc; those who begin by seeing nothing more, therefore, need not to be discouraged; a little patience and time will enable them to see what more practised persons describe. The eye to be examined may be more fully observed by dilating the pupil with atropine—a drop of a solution, one grain to a pint of water, or one of the atropised gelatines prepared for me by Savory and Moore, each of which contains one hundred thousandth of a grain of atropine, and will



maintain dilatation during several hours. This acts also perfectly well with rabbits or cats.

The first thing seen is the red reflection of the choroidal vessels showing through the transparent retina; and when the eye observed is directed upwards and inwards, we see the usually circular disc of the optic nerve, encircled by a double ring, cream-coloured or very faintly roseate or grey, and surrounded by the red choroid. The two rings are the apertures in the choroid and sclerotic, of which the former is the smaller. From out this disc we see springing the retinal artery and retinal veins, sometimes centric, at others excentric in their passage. The artery is easily recognized as being somewhat smaller in calibre, and of a lighter red. The artery usually divides into a superior and inferior branch, each of which subdivides forthwith into two secondary branches, and these again continue to subdivide, dichotomously, running forward to the anterior limits of the retina. The veins, which are somewhat larger and deeper coloured, usually pierce the disc of the optic nerve in two trunks. Pulsation may occasionally be detected in the veins by watching carefully their colour, which seems to change at each impulse just where they pass over the edge of the optic disc and bend to pierce the nerve.



Fuller details of the ophthalmoscopic appearances of healthy eyes, both human and animal, will be found in Zander's treatise, excellently edited and translated by Mr. R. B. Carter, of

Stroud. In the healthy eye the aqueous humour, lens, and vitreous humour are clear, and do not in any way obstruct the passage of the light. It is otherwise in disease; and this brings us to the discussion of some of the practical applications of the ophthalmoscope. Here, perhaps, I may be permitted to quote some of the paragraphs of a paper which I read lately on the subject before the Harveian Society.

Taking up the diagnosis of the various forms of disease, any of which would have been held to constitute the condition known as amaurosis, it may be noted, first of all, that, even in the hands of the novice, ophthalmoscopic examination supersedes those chapters in ophthalmology which were formerly devoted to the means of distinguishing between incipient cataract and amaurosis. In the past, and even at present, with those surgeons who are content to treat deep-seated diseases of the eye by guessing at their nature, and have not adopted the systematic use of the ophthalmoscope into their practice, the functional annoyances which commonly occur at the outset of the formation of lenticular cataract, have been, and are, fertile sources of deception. The patient complains of frontal pain, of confused vision, stars of light, and some other vague symptoms which characterize the outset alike of many forms of deep-seated disease of the eye, and of the fatty degeneration of the lens which commonly gives rise to lenticular cataract, probably from coincident swelling of the lens. An error arising from this source has many times condemned the unfortunate subject of a commencing cataract to the severe treatment thought appropriate to the unhappy class of amaurotics. The kind of alteration in the lens, imperceptible by any other means than the ophthalmoscope, is the slightly opaque striation of the substance of the lens sometimes seen in an early stage. These opaque striæ may occupy either the anterior or the posterior segment of the lens, and spring from the centre of the crystalline or converge towards the centre from the circumference. In order to see the latter, the pupil must be fully dilated with atropine; as, indeed, for the purposes of complete ophthalmoscopic examination it always needs to be; and then, just as the greatest expert cannot discover them except by ophthalmoscopic illumination, so, neither with its aid, can they be passed over with ordinary care. In order to be quite sure in any delicate case, it is well to lower the light a little, and use only a feebly illuminating power, as a very strong light may overpower a commencing opacity, and render us unable to detect the striæ. This practical caution applies equally to all other conditions of opacity in the transparent media. In two cases lately I have been able to set at rest doubts of this kind, which happened to be in the persons of medical men, who were much disquieted by the symptoms—one a member of this Society. In a third case I have recently detected incipient cataract (peripheric striæ) in a gentleman supposed to be suffering from commencing glaucoma.

It is of frequent occurrence to find the capsule of the lens stained with black spots: these are stains left by the uveal pigment, and occur usually after an attack of iritis, when the iris has been in contact with the lens. When the iris has been adherent, a complete ring of pigment may often be seen on the surface of the lens. A day's experience at any ophthalmic clinique can mostly show examples of this condition; but it is only when these deposits are numerous, and in the central line of vision, that they become troublesome. They are then met with as the sequences of severe choroido-iritis, and usually coincide with further mischief in the vitreous and choroid.

The vitreous, under the influence most commonly of choroiditis, and usually syphilitic choroiditis, presents alterations of the most striking character for ophthalmoscopic observation. The patients who offer these changes complain usually of considerable dimness of sight, which on examination is found to include both diminution in the acuteness of visual perception, and restriction in *the field of vision*, or extent of any object seen at once. The great source of trouble to them is, that when they lift the eyes or move the head, black corpuscles, or streaks, or webs, float before their eyes, and obscure the objects at which they are looking; and when the eyes are kept still, these fall again and disappear. Examine now the eyes of such an one, and you will see that the phenomena described are due to the existence of actual shreds, corpuscles, or webs of fibrous and albuminous exudation, which float in the vitreous, and at each motion of the eye rise in clouds and obscure the fundus, so that you can barely see it, or perhaps not at all. These conditions, I say, are mostly specific, but not invariably. They are sometimes the result of scrofula, and probably of other forms of choroiditis.

Here, then, are a large number of cases in which the ophthalmoscope transports us at once from the regions of the known to the unknown. There are other classes of cases equally striking. Let me take illustrative examples. Two persons apply for advice, complaining that the sight has been gradually growing more and more dim, perhaps in one eye,—it may be in both. The progress of the disease has been insidious and nearly painless. The eyes are to all external appearance healthy, except probably that in both patients the pupils are partially dilated and sluggish. The ophthalmoscope helps us to solve the problem.

The one is a case, it may be, of slow atrophy of the optic nerve, proceeding from central disease of the brain—from pressure on the optic tracts of nerve within the skull, or from defective nutrition following losses of blood. We find the nerve glistening white and slightly cupped, the arteries small, the fundus otherwise healthy. In the other we recognize at once, in the fulness of the veins, their pulsation, and the marked excavation of the optic disc, the indications of excessive tension of the eyeball and undue pressure of the nerve. The first requires careful constitutional treatment and a long course of studied hygiene and medication; the second calls for direct and immediate interference, with the view of relieving the intra-ocular pressure. In the diagnosis of this great class of glaucomatous disease of the eye—disease characterized by loss of vision, sometimes slow and sometimes rapid, but always characterized by definite ophthalmoscopic signs: cupping of the disc, pulsation, fulness of the veins, and it may be, more or less haziness of the transparent media, ophthalmoscopy has rendered a most brilliant and inestimable service. Prior to the introduction of the use of this instrument the disease was of an unknown pathology; its results were fatal to vision, but there were no means of diagnosing the conditions attending the earlier stages, and blindness followed almost certainly and inevitably. The investigation of the disease has brought us a remedy in the excision of a portion of the iris—a practice introduced by Von Gräfe, of Berlin, and of which the success is in suitable cases most gratifying.

Another series of examples may be chosen to illustrate the application of ophthalmoscopy. I avoid giving details here, but it is perhaps right to say that these are not fanciful sketches, but notices of cases in my experience and taken from my note-books of practice. Two persons are asking for advice as to the management of their eyes for short-sightedness. Are both to receive the same advice? The ophthalmoscope alone can furnish positive data. With this we may discover a staphylomatous condition of the back of the eye, a bright excentric margin around the optic disc and edged with black pigment. Examining it closely, we may find that this pigmented edge gives evidence of progressive inflammation at the back of the eye, and extending to continuous and increasing atrophy and retrocession of the coats of the eye. This person is in danger of becoming rapidly made short-sighted or of losing sight altogether. We must prohibit the use of concave glasses for a certain length of time, and must adopt active and effectual measures for subduing the atrophic inflammation. In the other patient the ophthalmoscope may show us but little stretching or waste, and that not progressive, and will enable us then to calm his fears, to prescribe appropriate glasses, and to dismiss him to his occupation with ease of mind and safety. So with sudden loss of sight from intra-ocular hæmorrhage, the ophthalmoscope gives us information which could never have been guessed at without it, and guides us, not only to the local knowledge, but to the constitutional information essential for cure.

There are certain conditions of the eye which may warn any one that it is desirable that the condition of the vision ought to be investigated by the ophthalmoscope. Rapidly increasing short-sightedness is one of the most marked, and when this becomes associated with weakness of sight and loss of acuteness in the perception of small objects, the warning is very urgent. A diminution in the field of vision is another important indication of internal changes in the eye, of which only the ophthalmoscope can detect the true nature. It would be difficult, perhaps, to say whether more mischief is done and more suffering is caused by the total neglect of such symptoms or by their ignorant palliation by the aid of common spectacles, chosen empirically, because they facilitate vision for the time. The great use of the ophthalmoscope, then, is this: that it arms us with an instrument of precision, by which we can determine the precise local condition of the parts of the eye in which the function of sight is resident and through which it is regulated. If it cannot do all that we might ask, it is because the sense of sight is in truth a cerebral function, of which the eye is only an instrument; and in dealing with cerebral affections of the sight, it can indeed give us information which without it we should lack, but it leaves still to be desired more intimate acquaintance with first causes, which at present we can only discuss inferentially. To the amateur in science, and to the lover of nature, it discloses an exquisite spectacle, unknown till now, that carries observation into the inner chambers of the living eye, and displays its wonders and its beauties. The observation is perfectly painless, and may easily be effected: rabbits, for example, submit to it with great calmness and composure, and at the College of Physicians' *soirée* last year, a little pet white rabbit of mine sat up calmly in a box which I had made for the purpose, and was examined, by the aid of a modification which I devised of Liebreich's demonstrating ophthalmoscope, by many score of observers. Another modification of Liebreich's ophthalmoscope by Messrs. Smith and Beck is figured on page 458. Mine has the advantage of being adapted for use even amid a blaze of light, and it cannot easily be disarranged; two qualities valuable in an instrument for demonstration.

ON THE MEANS OF COMMUNICATING BETWEEN GUARDS AND PASSENGERS ON RAILWAYS.

BY T. SYMES PRIDEAUX.

IT is so very palpable and obvious that, according to the doctrine of chances, every now and then in the running of railway-trains cases will occur where some casualty to the carriage or its occupants renders it of the utmost importance that one or the other should receive immediate assistance, that it seems extraordinary that such a certainly recurring contingency was not provided against at the commencement of the railway system of locomotion. What, however, is still more surprising is that the repeated examples of the urgent necessity that exists for some means of communication between the passenger and guard have failed to obtain for the travelling public a safeguard so necessary for their security. Quite recently, two unfortunate passengers have had to struggle for their lives with a furious madman for a space of twenty minutes, and, as commonly happens on such occasions, the paroxysm was attended by such an increase of strength on the part of the maniac, that, notwithstanding his fellow travellers were fortunately both powerful men, they were several times on the point of being overpowered, and when assistance arrived were nearly exhausted. It has sometimes happened to passengers to feel the floor of their carriage gradually crumbling away beneath their feet; and conscious of their utter powerlessness to aid themselves, they have had no resource but to await, in a state of hopeless terror easier to be conceived than described, the arrival of the moment when their last support should be shattered asunder, hurling them bruised and maimed on the iron tramway, to be crushed and dismembered by the following carriages. On other occasions, the occupants of railway carriages have had presented to their imagination the horrible fate of being burnt alive, not as a remote contingency, but as an instant and pressing danger which the rapidly increasing smoke led them from moment to moment to expect to burst upon them. Cases of insult and outrage to females from drunken or ill-disposed men are of frequent occurrence, and it is difficult to conceive an instance of a narrower escape from loss of life or serious injury than one of these recently afforded.

That passengers should be thus exposed to unnecessary danger and peril of life, or bodily injury in travelling by railway, to say nothing of the alarm and apprehension which the knowledge of this insecurity begets in many, without any steps being taken by railway companies to remedy the evil, has very naturally excited the indignation of the public. For a long period there had existed a smouldering dissatisfaction on the subject, and at length, upon the murder of Mr. Briggs, this found vent in a loud and unanimous demand that active measures should at once be taken, if not voluntarily by the railway companies themselves—in which the public had little faith—then compulsorily in obedience to a Government order or legislative enactment.

In short, public opinion and common sense have alike long ago decided that passengers on railways ought to be furnished with some means of communication with the guard, and recent occurrences have caused some provision of the kind to be called for more loudly than ever; yet the railway companies show no intention or disposition to comply with the clearly expressed wishes of their customers. Unquestionably, however, the will of the public ought to give the law in the matter, unless some very substantial ground can be shown for not complying with it; for surely no one can have so good a right to determine the conditions and circumstances of locomotion as the travellers themselves. For a railway that carried only schoolboys we can understand its being pleaded as a reason for their demurring to acquiesce in the desires of their patrons, "that they were no judges of what their own safety required," the necessity of restricting the right of private judgment in childhood being universally recognized; but to assign such a ground for setting at defiance the clearly expressed wish of the community at large would manifestly border on impertinence.

Let us now examine how and why it is that the wishes of the public have been and continue to be set at naught in this matter. *Do there really exist sound grounds of objection, based either on difficulties in effecting the object, or on injurious consequences to be apprehended as a result?* We do not hesitate to answer this question most explicitly in the negative, and to affirm that the only lion in the path is the indisposition of railway boards and their officials—an indisposition made up half of professional jealousy and half of the dislike of dictation natural to men who have played the *rôle* of autocrat so long that they can hardly realize the fact of the public presuming to have an opinion of their own on any point of railway management, however much their own safety may be involved in it; the business of the aforesaid public, in their eyes, being properly restricted to paying the fare, and bringing an action for damages in the event of bodily injury. We answer the question thus positively and unhesitatingly, because, in the first place, *nothing can be easier than to devise the means of transmitting any required signal from one part of a train to another;* and, in the second place, *nothing can be weaker than the arguments resorted to as an excuse for doing nothing.*

In the first rank of these has always figured the handy assumption that a prodigious amount of inconvenience and loss of time would arise from frequent stoppages of trains by nervous old women of both sexes resorting to the danger-signal without adequate cause. One conclusive reply to this is, that the inconvenience, granting it came into existence, would fall on the public, who would be the best judges on which side the balance of advantage lay, and the only proper persons to decide whether time should be sacrificed to safety or safety to time. A second answer is the fact that for many years such a danger-signal—open to employment by any passenger—has been in use on the railways in the United States without these anticipated, but as it appears purely imaginary, evil consequences resulting, and we have yet to learn that the English travelling public are less capable of exhibiting discretion and self-control than their transatlantic descendants. Thirdly, such a danger-signal has actually been in existence on the South-Western Railway for four months, easily accessible to all, without having once been put in action by a passenger. Briefly, then, to sum up in one word our opinion of the argument for doing nothing founded on a hypothetical picture of stoppages—we say, "Fudge!"

With the electric telegraph in daily and familiar use, it is really difficult to comprehend how such an amount of ignorant credulity, or perhaps we ought rather to say incredulity, can coexist amongst us as is involved in the acceptance and belief of the silly tales of the great, if not insuperable, difficulties to be surmounted in arranging a simple and efficient means of communication from carriage to carriage of a railway-train in motion which have been set on foot by railway magnates as an excuse for not complying with the wishes of the public. In short, let it clearly be understood that there is neither a difficulty to be solved nor an invention to be awaited, but simply an indisposition to be conquered. As soon as the existence of a means of communication between the passengers and guard is made imperative on all railways by the legislature, a method will straightway be found of complying with the law; but as long as no such law exists, so long shall we be treated to tales of insuperable difficulties, and be told that no practicable and unobjectionable plan of effecting the object has yet been discovered. In short, those who are anxious on the subject may rest assured that immediately the Board of Trade discard the motto "*Dolce far niente*," in their dealings with railways, and refuse any longer to accept spun moonshine as an excuse for doing nothing, all difficulties will vanish, and the public will at once obtain that increase in the safety of travelling by railway which has been so long withheld under various flimsy and ridiculous pretences.

We further venture to predict that when this time arrives, scarcely any two railways will adopt identically the same arrangements, whilst but little difference will be found to exist in the comparative efficiency of each. All will be required to fulfil certain recognized conditions, yet the methods had recourse to for attaining the prescribed ends will vary within certain limits in their details. In the United States the means of communication employed is of the simplest—not to say rudest—kind; but no complaints are heard of its insufficiency. A central cord, in communication with an alarm-bell on the engine, traverses the whole extent of the train, just below the roofs of the carriages within easy reach of any passenger who chooses to rise from his seat. Yet the power possessed by every individual of signalling to the guard to stop—if practicable without danger—is not found to be abused, nor attended with practical inconvenience. No impediment exists to prevent the same primitive plan being adopted on English railways; but we are inclined to believe the power of commanding a wider range of signals, bestowed by the use of electro-magnetism, will eventually secure it the preference, especially as the conditions for obtaining a durable and permanent battery power are now so well known, and all the attendant circumstances connected with its use so thoroughly understood, that the facility of its application, its manageability, and, above all, its non-liability to derangement with ordinary care, leave nothing to be desired. In short, never was the old proverb, "Where there is a will there is a way," more applicable than to the present question.

One of the first points that presents itself in determining how the desideratum sought is to be practically attained is the question of approximating the ends of the foot-boards of the carriages, so as to enable the guard to traverse the train throughout its whole extent. If this is not to be adopted, clearly the only alternative is to entrust the passengers with the power of signalling to the engine-driver to stop the train—who must then use his own discretion as to the earliest period at which this can be done with safety. To arrange for passengers to signal to a guard possessed of no power of putting himself in communication with them to ascertain what is the matter, for the purpose of enabling him to signal to the engine-driver what is to be done, would be palpably objectless and absurd. Those whose policy is obstruction, have pretended to discover in the connection of the carriages by footboards, or rather in the proposition that their servants should traverse the train by this rout, something so hazardous to their lives that they scruple to ask them to discharge so dangerous a duty. This tenderness of the safety of persons committed to our care is, doubtless, a most meritorious feeling, but it is to be regretted, in the present instance, that it should be so engrossed with the safety of the one or two attendants on a train as to overlook that of the one or two hundred passengers. We venture to say that the simple expedient of a handrail, at a height a little above the head, running round the train, on which a continuous hold-fast with one or the other hand should be maintained, would reduce the danger to a vanishing point, to a risk so infinitesimally small as hardly to admit of comparison with that which a seaman encounters in going aloft to reef topsails.

Great stress has been laid upon the fact that a French Commission, appointed to inquire into the subject in consequence of the murder of a judge in a railway-train, expressed the opinion that, probably, the connection by footboards facilitated the escape of the assassin, and hence that such an arrangement did not afford much security to passengers against attack. Truly, the connection of this vague opinion with an argument against continuous footboards as an *adjunct* to alarm signals is the reverse of obvious, and the attempt to make such an indefinite and inapplicable dictum do duty as an argument must be taken as an indication of the poverty of the case. Neither will the English public soon forget—seeing it came so recently within the range of their own experience—that the absence of any connection between the carriages of a railway train neither prevents murder nor the facile escape of the assassin.

There exists, then, no valid reason why we should not resort to continuous footboards as a means of enabling the assistance of the guard to be procured without entailing as a necessary consequence the stoppage of a train. At any rate, before discarding this resource, it is well we should recognize the fact that there is no alternative between entrusting to the discretion of each passenger the power of signalling the stoppage of the trains and the existence of a means of communication between the carriages, through which assistance can be afforded whilst the train is in motion. Assuming this means of communication to exist, the question arises, what are the conditions, the fulfilment of which must be regarded as indispensable in any system of signals. The least that can be required seems to us to be that every passenger shall have ready access to a signal, the action of which will warn the guard and at the same time display some distinguishing sign to serve as a guide to the compartment whence the signal proceeded. Upon the arrival of the guard, he certainly ought to have, on the spot, the means of signalling to the engine-driver to stop, should it be necessary, without losing time by traversing back to the end of the train. Supposing, then, the means of signalling to the engine-driver, as well as to the guard, to exist in every compartment, the question arises whether it might not be desirable to entrust the use of both signals to the discretion of the passengers; thus giving them power either to call the guard simply, or tell the driver to stop and call the guard at the same time; that in urgent cases, such as the breaking of a spring, or an axle, or a carriage getting off the line, the time lost in summoning the guard, as a necessary preliminary to warning the engine-driver, might be saved. We know that a great prejudice exists against committing the power of stopping a train to the hands of passengers, but we do not share in this prejudice. We have a higher opinion of the discretion and common sense of our countrymen, and believe when the experiment is tried—as tried it assuredly will be—these predictions of stoppages for trifles and consequent loss of time will be signally falsified by the result.

In consequence of the interest exhibited by the public in the subject, and specially by her Majesty, as evinced by her letter to railway directors on railway accidents, the managers of the Polytechnic Institution determined to open an exhibition of inventions designed to promote the safety of railway travelling, and accordingly issued an invitation to all inventors to send their models or drawings to be exhibited in their collection. Much surprise has been expressed by many of the public who have visited it and examined the drawings and models referring to the subject of communication between the passengers and the guard, at the paucity of invention displayed, both in the small number of plans sent in for exhibition and the small amount of ingenuity which characterized the assemblage as a whole. The result, however, is perfectly intelligible to the initiated and such as might have been expected.

Supposing a crotchety old man entertained an objection to having bells in his house which he did not choose to avow, and so gave out that there was some peculiarity in the shape of his residence, or the arrangement of its rooms, which presented great difficulties to their employment; but that at length, pressed by the remonstrances of his guests, he issued invitations to the public to send in plans. The class most competent to furnish them, the professional bell-hangers, would probably stand aloof, not only because their knowledge of the subject would enable them to appreciate more clearly than others the hollowness of the pretext hitherto assigned for dispensing with bells, but also from a feeling that it was derogatory to their professional character to countenance the delusion that any invention, properly speaking, was required to execute what any tradesman, ordinarily master of his craft, would be competent to perform. Our readers will now understand how it happens that so few drawings and models have been sent to the Polytechnic Institution, and that out of these few not one has been sent by a professional telegraphic engineer. In short, the character of the exhibition becomes perfectly intelligible when it is regarded as having emanated from a few well-meaning simple-minded individuals, who have been imposed upon so far as to receive the stories of the alleged difficulties of signalling between the carriages of a railway-train for statements made *bonâ fide*, instead of being mere pretexts for doing nothing, made up of an assortment of the first plausible fallacies that came to hand considered capable of hoodwinking that portion of the public whose simplicity and ignorance of the subject rendered them credulous and laid them open to deception.

Most of the railways have a telegraphic engineer on their staff, and we entertain a very decided opinion that almost any of these gentlemen, if the task were set them by their employers, would arrange the details of a perfectly feasible plan of signalling between the carriages of a train in motion in a couple of hours; such a plan as, with a few minor alterations dictated by experience, would be capable of being practically adopted with success; for we are unable to conceive that a skilful telegraphic engineer would have any difficulty in devising such modifications in the connecting wires of the battery as the occasional disconnection of the carriages and the flexibility of the train rendered necessary.

The best of the plans for communicating between the passengers and the guard we have yet had an opportunity of examining is one which has now been in use for four months on the Hampton Court branch of the South-Western Railway, where any of our readers who desire, may see and examine it for themselves. The author of this—certainly to a large extent practically successful—plan is Mr. W. H. Preece, the telegraph superintendent of the South-Western Railway Company, and the details of the mechanical arrangements are as follows :—

Every compartment is provided with a signal handle or bell-pull, consisting of a drop-ring inclosed in a circular case about four inches in diameter, the front of which is fitted with a glass, so that at first sight it might be mistaken for a time-piece or aneroid barometer, having a white dial or face on which directions for the use of the signal are painted. The signal handle is defended by glass, thus necessitating the breaking of the latter before it can be used, with the object of exercising a check on its trivial employment; and at the same time the glass is so thin as to offer little resistance to fracture should it become necessary to obtain access to the ring. The dial and ring occupy a central position in the compartment, above the heads of the passengers, and just below the umbrella-rack. A pull on the ring, acting through two diverging wires guided by pulleys concealed beneath the partition, disengages two catches, one on either side of the carriage, each of which releases in its turn an arm or lever, which in falling assumes a position at right angles to the sides of the carriage, from which it projects on either side like wings, and being coloured red and white, in alternate squares, is sufficiently conspicuous to indicate at once the compartment from which the signal proceeded. The descent of these levers completes the connection between the poles of an electric battery in the guard's van, and instantly sets one or more bells ringing, which can only be stopped by replacing the arms or levers in their original position. Under the existing arrangement, the guard has the power of communicating five signals to the driver, by whom they are to be acknowledged on the whistle. But as at present there are no connecting foot-boards or other means of communication by which the guard can reach the compartment from which the signal emanated, and learn what is the matter to enlighten himself as to what signals it may be necessary or advisable to transmit to the driver; this end of the scheme must at present be considered an abortion, or at least incomplete. The mode of carrying the connecting-wires from carriage to carriage, so as to combine sure electric connection with facility of detachment, is very simple and ingenious, and leaves nothing to be desired. The coupling and uncoupling can be effected instantaneously; at the same time should a carriage become detached from a train by accident, the alarm-bell is at once put in action.

Such is the plan of Mr. W. H. Preece, and after four months' use none of the threatened practical objections seem to have developed themselves. No passenger has ever yet set the alarm-bell in action, nor has the train once been delayed by its use. In conclusion, then, let us express a hope that we have heard the last of the chapter of difficulties—of predictions of insufferable practical obstacles. We venture to think a railway-train may be fitted with alarms to be rung, by mechanical or electric means, pretty nearly as easily as a dwelling-house. Surely, a very small amount of common sense is required to perceive that neither the separation of the carriages nor the flexibility of the train can offer any serious impediment to the introduction of a system of train signals; and that, in spite of all that may be alleged to the contrary, the indisposition of the railway authorities is in reality the only obstacle that impedes the realization of the wishes of the public.

IS THE WHITEBAIT A DISTINCT SPECIES ?

BY THE EDITOR.

NOW that all London is rushing away to Richmond, Greenwich, and Blackwall, to indulge in whitebait dinners, a few words anent the history of the little fish which is such a source of good fortune to the proprietors of the "Star and Garter" and the "Trafalgar," may not be out of place. We believe it is usual in cases like the present to say in the first instance something of the chronologic history of the subject; in other words, to relate when and where first mention was and is made of it. If we have to depart from so excellent a custom, it is not because we have not endeavoured to make ourselves acquainted with the facts. We beg, therefore, the indulgence of our readers. In vain have we travelled over the pages of ponderous encyclopædias, and evoked the assistance of that refuge of all literary unfortunates, the reading-room of the British Museum. Of our efforts to obtain information from the materials in the latter institution we pride ourselves a little, when we consider the wonderful disregard for public convenience and the magnificent contempt for anything in the shape of useful arrangement which the managers of that part of our national collection display. We repeat, therefore, that we trust our readers will pardon our inability to supply them with the early history of the whitebait. That it has an early history is of course undoubted, but it must be handed down by abler hands than ours. At present it seems to us to be very much in the condition of "Topsy," who in ignorance of her ever having been born, arrived at the inevitable conclusion that she "growed." It is really strange that in none of the earlier dictionaries — the work of "the great lexicographer" included—does the word whitebait occur. The same may be said of almost all the encyclopædias. Indeed, in only three or four out of the dozen or more of these compilations which our language presents, are there half a dozen lines devoted to the subject of this article. In most instances we find under the head of whitebait the statement that it is "a small fish esteemed by Londoners," or "a species of the genus Clupea." The "Encyclopædia Britannica," "The English Cyclopædia," and Rees' "Universal Dictionary of the Arts," are we may say the only three from which any information may be gleaned, and the account contained in the first of these is shamefully defective. In the article "Fisheries," which in some respects is well compiled, we find ample statistics of the quantity of fish, mollusks, and crustacea annually consumed in England, but not the faintest mention is made of the whitebait. The article "Ichthyology" is just as barren, for our silvery friend is disposed of in three lines, which tell how admirably his relation to piscine society has been demonstrated by Mr. Yarrell. The description in the "English Cyclopædia," though brief, is at all events accurate, and, save that the history is omitted, is much to the point. Finally, in Dr. Rees' old "Dictionary" we find the most voluminous account of any; but, unhappily, it is a vast tissue of blunders and mis-statements from beginning to end. As far as we have been able to discover, the only sources of correct knowledge concerning the character and zoologic position of the whitebait are Mr. Yarrell's "History of British Fishes," his memoirs in the *Zoological Journal*, and the "Histoire Naturelle des Poissons" of MM. Cuvier and Valenciennes; but of these we shall speak more anon.

Waiving the question as to when the whitebait was first observed and eaten, we may state that as early as the middle of the last century it was tolerably familiar to the London public. This has been especially pointed out by Pennant, who also informs us of a curious fact, viz., that at that period the eating of whitebait dinners was considered to be rather a vulgar and degrading habit. What extraordinary changes the tastes of a people undergo in the course of fifty or sixty years! How fickle is fashion! How capricious and irrational are her dictates! One hundred years ago the individual who partook of whitebait after the manner of certain classes of the time, would have been tabooed by polite society—whilst, to-day, a whitebait dinner at Richmond is regarded as a species of fashionable luxury.

> Tempora mutantur, et nos mutamur in illos.

Who knows but that in 1965 the common whelk, which now holds such an ignominious position upon the stalls of the "East-end," may be served up "*sautée dans sa glace*," as a sort of aristocratic *entrée*. That it may not be thought we exaggerate, we quote Pennant's words :—*

> During the month of July there appear in the Thames, near Blackwall and Greenwich, innumerable multitudes of small fish, which are known to the Londoners by the name of whitebait. They are esteemed very delicious when fried with fine flour, and occasion during the season a vast resort *of the lower order of epicures* to the taverns contiguous to the places they are taken at.

Indeed, another circumstance would seem to show that the whitebait must, till within recent years, have been a favourite of the masses only—the fishery was for some time suppressed, or attempted to be suppressed, by the Lord Mayor. Now, had the fish been as congenial to the aldermanic palate as it is in these times, this result would hardly have fallen out. Whether the City dignitary's efforts were successful or not we cannot say ; but at any rate the fifteenth printed rule which emanated from him and his court orders, that "no person shall take, at any time of the year, any sort of fish usually called whitebait, upon pain to forfeit and pay five pounds for every such offence ; it appearing to this court, that under pretence of taking whitebait, the small fry of various species of fish are destroyed." It is almost needless to say that this rule was framed under a complete misconception, for, from the nature of the apparatus employed in the capture of whitebait and the season in which they are taken, the only fry which can pass into the net are those of gobies, sticklebacks, and shrimps, the destruction of which is hardly a matter of much importance. The reader must not suppose that nowadays whitebait are to be taken as high as Blackwall and Greenwich. Father Thames has fallen since Pennant's time into habits of uncleanness, and the whitebait, with a due regard for their gills and nostrils, decline to come up beyond Gravesend and Woolwich. At these points, then, the fisheries are held, commencing usually in April, and terminating in September. Being strictly a sea-fish, the whitebait can only be taken when the tide is at flood, and the water decidedly brackish; under such circumstances the fishermen moor their boat in mid-stream, and proceed to their labours. The net is a sort of bag-net, with a small mesh, which diminishes in size toward the end—in fact, is somewhat like that employed in weirs for taking eels. It is attached by its mouth to a wooden framework, about three feet square, and has its purse so arranged that it can be opened or closed at will. The framework, when set in operation, is placed by the side of the boat at a depth of about four feet from the surface of the water, and is retained in this position by means of ropes, which pass from its upper part to the gunwale of the boat, and are there belayed by the fishermen. From time to time the purse is drawn out of the water, and emptied of its contents. When a sufficient number of the fish have been taken, they are transmitted by boats, appointed for the purpose, to the several agents at Blackwall and Greenwich; but the fishing craft remain upon the grounds during the entire season. That the whitebait is essentially a marine fish is proved by the fact that the various attempts to preserve it alive in wells of fresh-water provided in the boats have been invariably unsuccessful.

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* "British Zoology," by Thomas Pennant. London : printed for Benj. White. 1776. Pp. 371-2, vol. iii.

The whitebait being a fish which is solely eaten by Londoners or visitors to London, it naturally awakens little interest in the minds of those who live at a distance from or seldom visit this great metropolis. Nevertheless, it is a creature which has from time to time engaged the marked attention of naturalists, who have sought to discover whether it was a species *per se*, or was merely the young of some other fish. Its claim to the rank of species was persistently denied it by all naturalists till in the year 1828 Mr. Yarrell, who carefully studied the question, pleaded its cause before the fellows of the Zoological Society, and obtained a verdict in its favour. The whitebait all along appears to have merited the privileges and immunities which belong to mature members of his family, but through the prejudices and blunders of Pennant, Donovan, and others, he continued for half a century to be regarded as a minor. No one believed he was a perfect fish, and hence he was considered to be the fry of some more favoured denizen of the ocean. The opinions as to his paternity were divided between the shad and the bleak. Donovan advocated the former, and the latter found a not very sanguine supporter in old Pennant, who, in the work we have already alluded to, makes the following remarks:—*

> That they (whitebait) neither belong to the shad nor the sprat is evident from the number of branchiostegous rays, which in them are eight, in this only three. That they are not the young of smelts is as clear, because they have not the *pinna adiposa*, or rayless fin; and that they are not the offspring of the bleak is extremely probable, since we never heard of the whitebait being found in any other river, notwithstanding the bleak is very common in several of the British streams; but as the whitebait bears a greater similarity

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* Loc. cit., p. 372.

> to this fish than to any other we have mentioned, *we give it a place here as an appendix to the bleak,* rather than form a distinct article of a fish which it is impossible to class with certainty. . . . . Its usual length is two inches.

Pennant's conclusion was certainly a remarkable one, for though he felt compelled to admit that he was unwarranted, scientifically, in classing the whitebait with other fish, still, with that desire for some fixed belief which is so common a characteristic of mankind, he determined that it must be a bleak. Dr. Shaw, in his "General Zoology," adopts Pennant's view, but Mr. Donovan, both in his "History of British Fishes" and in an article in "Rees' Cyclopædia," contends that the shad is the progenitor of the whitebait. Writing of the former (*Clupea alosa*), the author of the article * we refer to remarks :—

> The young of this species has been very recently ascertained by us to be no other than the little fish known commonly by the name of the whitebait.

Here follows an analysis of pre-existing opinions, in which the writer, in the most dogmatic conceivable manner, proceeds to annihilate the views of others, and to censure the imperfect observations which led to their adoption. His condemnation of Pennant is interesting, if only from the circumstance that it is far more applicable to the writer himself, who has been guilty of all that he attributes to his predecessor.

> Every circumstance considered (says Mr. Donovan), we cannot avoid concluding that much of the prevailing errors respecting whitebait has arisen from the incautious observations of Mr. Pennant on this subject; that this author never saw the whitebait, and that succeeding naturalists, too implicitly relying on his observations, have been inadvertently precipitated into those errors which the most casual observation of the fish in question would have enabled them to detect. If, however, contrary to this assertion, Mr. Pennant ever did examine the fish, his specimens must have been either in a most imperfect state, or his investigation of it unpardonably negligent. His figure conveys no just idea of the fish, and his critical animadversions are laboriously intricate and defective. . . . . The whitebait certainly possesses every criterion of the species as evidently as the parent or full-grown fish; its outline is the same; its fins are alike: it exhibits the same serrations on the abdomen, and cleft on the snout; and, what is even remarkable in a fish of

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* "The Cyclopædia; or, Universal Dictionary of Arts, Sciences, and Literature." By Abraham Rees, D.D., F.R.S. London. 1819.

this small size, *the lateral range of dusky spots is perceptible through the beautiful silver scales, as in the larger fish.* It exhibits, in a word, the most perfect but diminished view of the common shad, not a solitary character excepted.

Nothing more indicative of self-conceit can well be imagined than the foregoing remarks of Donovan, and, moreover, nothing could more fully demonstrate the entire force of the error into which he fell. The sentence in which he tells us how, in the whitebait, the range of spots may be perceived through the silver scales, proves incontestably that the specimens upon whose examination he founded his opinion were not whitebait at all, but genuine shads; for, as we shall see presently, the absence of the spots is one of the most prominent features which seem to mark out the whitebait as a distinct species. Turton, in his "British Fauna," Fleming, in his "History of British Animals," and a host of other naturalists followed in Donovan's track, and swore by him and his theory. But at last, in the year 1828, as we have already said, a new light was thrown upon this obscure subject, and the muddle which resulted from the in great measure foregone conclusions of Pennant, Turton, Shaw, Fleming, and Donovan was removed. To Mr. Yarrell the credit of clearing up the mystery is wholly due, and to him we owe all that is exact in our knowledge of the whitebait.

The whitebait belongs, like the shad, herring, sardine, anchovy, and sprat, to the great family of abdominal-soft-finned fishes, known as *Clupeidæ*. It comes under the genus *Clupea*, of which the shad is *C. alosa;* but since it has now to be regarded as a separate species, it has received the specific appellation of *alba;* hence, when fully titled, it is styled *Clupea alba.* In France it is called *blanquette*, and is found in great abundance on the coasts of Picardy and Normandy, as well as in the Northern Ocean. Its anatomy has been rather fully detailed in the splendid treatise of MM. Cuvier and Valenciennes,* a work which will amply repay those who refer to it for the purposes of natural history investigation. The arrangement of the viscera in the whitebait resembles that of the herring; but the differences observable in the form of the digestive organs give more force to the specific distinction between the two than even the external characters. The alimentary canal commences as an extremely wide œsophagus, which occupies all the upper and front portions of the abdominal cavity. It ends in a very narrow conical sac; and from the right of this constriction may be observed a rising branch, which is of some capacity, and which, by occupying the inferior part of the abdominal chamber, renders the entire apparatus the more conspicuous. The pylorus is surrounded by numerous cæcal appendages, which are longer and larger upon the right side than upon the left. The intestine makes two folds, which approach each other in the left lateral portion of the abdomen; and in passing from the junction with the branch to which we have referred, it descends, and constitutes a simple straight rectum, which terminates in the anus. The liver is composed nearly altogether of a narrow lobe, situated upon the curved part of the œsophagus, and affords a good specimen of hepatic structure, the bile-cells being extremely well marked, even under a low microscopic power. The spleen, which is small, is seated upon the right side.

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* "Histoire naturelle des Poissons."

So much, then, for the general visceral anatomy of the whitebait. Let us now see, following Mr. Yarrell, why it is that his fish is not to be considered the young of the shad. The points of difference are striking and numerous. The shad enters our rivers in the month of May for the purpose of depositing its spawn; and, according to most authorities, it leaves for the sea in July. Now it is pretty nearly during this period that the whitebait fishery takes place; from which it is clear that, if the supposed relationship between the two fish existed, the individuals captured ought to be full-grown shads, and should contain roe. Such, however, is not the case: the fish known as whitebait are too small to represent mature shads; and, further, they never—during the "season"—present a trace of roe. From the continued observations of Mr. Yarrell, it appeared that, as a rule, the young shads do not make their appearance till the autumn; whereas, as we have already stated, the whitebait are caught in the spring—indeed, sometimes as early as the end of March. This naturalist succeeded, with some difficulty, in obtaining, towards the end of summer, complete and mature whitebait, and these he found to measure from four to five inches in length—a very great size when it is considered that those which are eaten during the season seldom exceed an inch and a half or two inches. Some of these specimens were found full of roe; and, what was more characteristic, they preserved the silvery appearance of the young fish, and presented none of those dusky spots which are invariably found upon the shad. Thus, then, we perceive the very serious objections to Mr. Donovan's hypothesis. Anatomical comparison of the two fish (*C. alosa* and *C. alba*) enhances the difficulty of believing these species are identical.

As the object of this paper is to give the results of Mr. Yarrell's researches, proving that the whitebait is a distinct and well-marked species of *Clupea;* and since a comparison of the characters of the *C. alba* and *alosa* is best made when their characters are placed side by side, we shall tabulate the differences in this manner, for the sake of perspicuity:—

In the Young Shad :—	In the Whitebait :—
The body is deep in proportion to the length.	The body is not so deep in proportion to length.
The colour of the back is bluish.	The colour of the back is a greenish-ash.
The lateral line is feebly marked.	The lateral line is clear and distinct.
The abdominal serrations are deeply cut, and much curved.	The abdominal serrations are not so deeply marked, and are less curved.
The silvery internal membrane of the abdomen is unstained.	The silvery membrane is stained with black pigment.
There is a series of dusky spots extending from the gill-flap.	There is no trace of spots.
The tongue is smooth and dark.	The tongue is rough and white.
The lower jaw has three strong teeth on the outer edge.	The lower jaw has no teeth upon the outer edge.
The snout is bifid.	The snout has no notch.
The whole edge of the upper jaw is covered with teeth.	Portion only of the upper jaw is covered with teeth.
The eye is comparatively small.	The eye is comparatively large.
The vertebræ in all shads, young and old, never exceed 55.	The vertebræ are invariably 56.
The formula for the fin-rays is :— D. 20, P. 19, V. 12, A. 21, tail 26.	The formula for the fin-rays is :— D. 17, P. 15, V. 7, A. 15, tail 20.

Besides the foregoing, there are differences, of course more or less relative, in the form of the dorsal fins and in the number of the cæcal appendages, which of themselves alone would be sufficient to warrant a distinction between the whitebait and the shad.

It may however be remarked, that although it is certain the whitebait is not the young of *C. alosa,* it is not *certainly* proved that it is a perfect species : it may be distinct from the shad, and yet may be the descendant of some other members of the genus *Clupea.* To us it appears not improbable that

Clupea alba may be the young of the herring. It may be urged against this idea that the herring is found in full roe during the month of September; but this, after all, would be a slender argument when it is remembered that the herring has two distinct periods of spawning in the year. The anatomical characters, as given in books, are to some extent against the hypothesis; but we fancy this part of the question requires to be re-worked before any definitive conclusion is accepted.

It is at all events a remarkable coincidence that in both the herring and the whitebait the number of the vertebræ and of the rays in the dorsal, pectoral, and caudal fins is the same.

The geographical range of the whitebait is wider than is generally supposed. It has been found in the Firth of Forth by Mr. Parnell;* and, as we have before stated, it is recorded as a native of the French and northern coasts by MM. Cuvier and Valenciennes. Doubtless, too, it would be discovered in many other of our rivers, were nets of a sufficiently small mesh for its capture employed. The food upon which it subsists consists almost exclusively of young shrimps and entomostraca. From the stomach of a single specimen, which measured about an inch and a half, we removed as many as six of these creatures, some of which were quite half an inch in length. Of course only the chitonous skeletons were present. Yet it is a matter worthy of the consideration of those who frequently indulge in whitebait. If, for example, we admit that shrimp skeletons are not of a very digestible or nutritious character, and are likely to irritate the delicate surface of the human stomach; and if, then, we allow that at a dinner an individual eats from sixty to one hundred whitebait, and that each of them contains the skeletons of four young shrimps, we shall arrive at the unpleasant conclusion that the said individual has swallowed from two to three hundred sharp, spiny, unpleasant, undissolvable skeletons, which must inevitably affect his stomach injuriously.

To those who have found the anatomical details of this paper uninteresting, the above fact may afford something for contemplation. At all events, in the pleasing hope that it may prove useful to some, we add the wholesome though hackneyed maxim, *Crede experto*, and for the present bid those who have so far accompanied us *Au revoir*.

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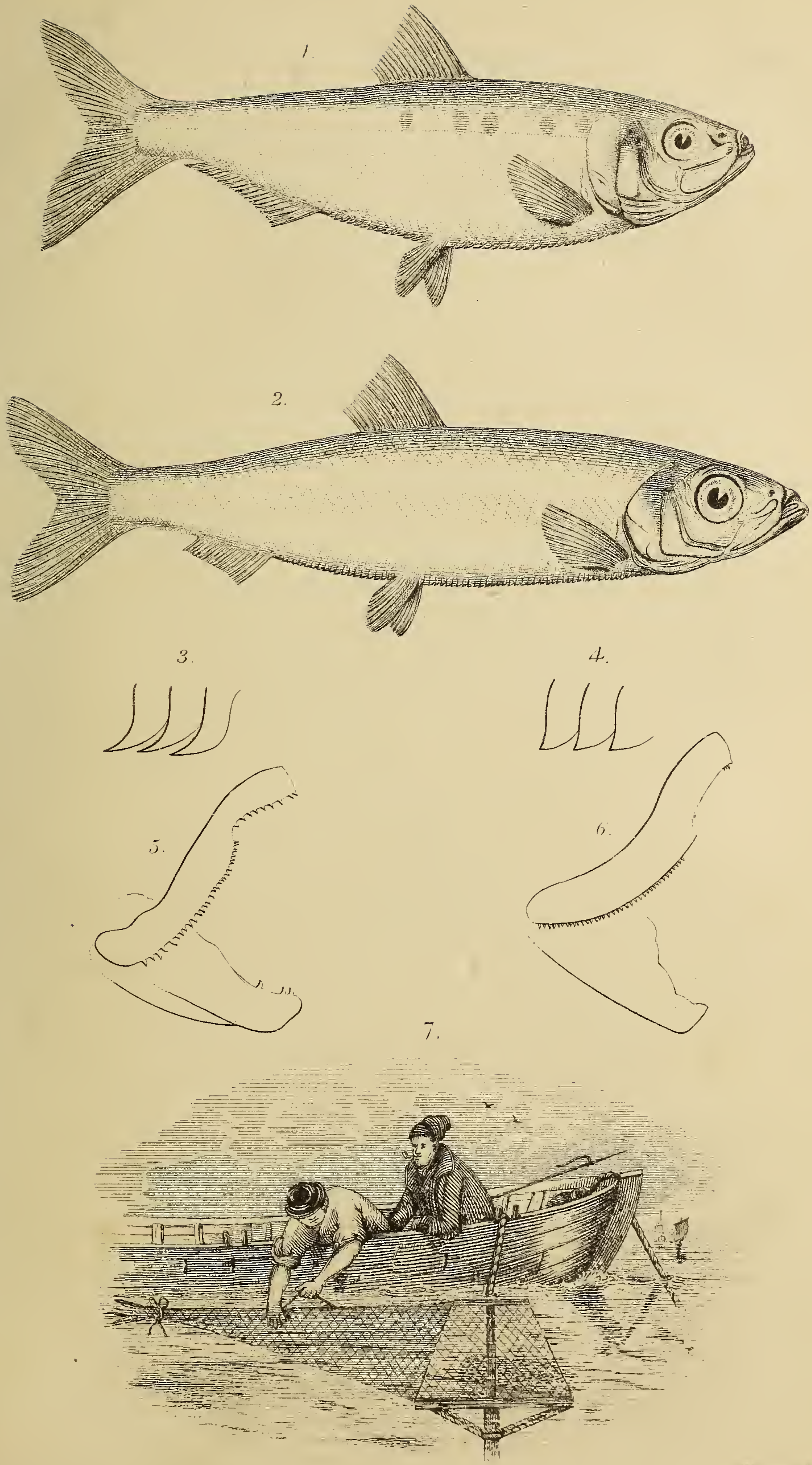
* "Proceedings of the Royal Society of Edinburgh," vol. i. (No. 9. 1836), pp. 141-2.

EXPLANATION OF PLATE XIX.

Fig. 1. Young Shad.
2. Whitebait of largest size found during the Season.
3. Abdominal serrations of the Shad.
4. Ditto ditto Whitebait.
5. Edge of Shad's Mouth, magnified.
6. Ditto Whitebait ditto.
7. Boat and Net, showing the mode of capture of Whitebait.

Plate XIX.



after Yarrell.

W. West lithᵗ

Whitebait and Shad.

BRITISH MUSEUM
NATURAL HISTORY.

REVIEWS.

PHYSIOLOGICAL ANATOMY.*

If we except the earlier writings of men like Wolff, we may say that the first impetus which the philosophic study of microscopic anatomy received in Europe was due to the admirable essays of Schwann of Berlin, and Schleiden of Jena. More than twenty-five years have rolled away since the treatises of these distinguished observers were first given to the public, and it may almost be said that from the date of their issue up to the present day the views promulgated in them have held their place in science. The doctrine which was propounded by MM. Schwann and Schleiden was that which is now commonly known as the "cell-theory," and it was enunciated with such a force of logical reasoning, and such an amount of what appeared to be histological fact to support it, that it proved absolutely irresistible. The cell hypothesis was admitted by all anatomists of the age to be little short of a grand truth; the expression of one of the great laws of tissue-development; and, as we have stated, it has since continued to hold an almost absolute sway over the minds of microscopists. In this country it found an able and enthusiastic advocate in the author of the volume now under notice, and we think it is not too much to assert that its hold upon English histologists has been mainly due to the plausible reasoning and ingenious illustration which Dr. Carpenter brought to bear upon it. In all his works upon physiology he has endeavoured to develope and support the cell-doctrine, and the eloquent manner in which he pleaded his cause, added to the skill always displayed by him in adducing evidence to bear out his case, brought him many followers.

But, after all, it must be admitted that the writer harped too much upon the same string, and even those who were most willing to adopt the cell theory found it occasionally pushed to such lengths, that they were compelled to be a little sceptical as to its truth. The cell was defined to be a closed vesicle with liquid contents and a nucleus, and having the power of growth and of multiplication. It was a sort of separate being, with a kind of independent existence. If it was required to form a tendon, cells were arranged in rows, their walls allowed to become confluent, and their nuclei the greater part to disappear. Muscle, in the same manner, was said to be built up through the agency of these wonderful little organisms; and so on with every other tissue in the body. Every animal organ was originally a cell or congeries of cells; even the ovum itself was a cell in which the "germinal vesicle" was the nucleus, and the "spot" the nucleolus. Such was the creed almost universally adopted, and Dr. Carpenter was its warm supporter.

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* "A Manual of Physiology, including Physiological Anatomy." By William B. Carpenter, M.D., F.R.S. Fourth edition. London: Churchill. 1865.

The most important character, perhaps, which serves to distinguish organic from inorganic matter is its constant liability to alteration; so it is with philosophy, or at least with those branches of it which are connected with medical science. That which we are prepared to swear by to-day we may have to regard as unworthy of confidence to-morrow. It must not, therefore, surprise our readers to learn that the view which Dr. Carpenter clung to with feelings of affection for so many years he has at length resigned. The most important feature in the present edition of his manual is his surrender of the cell-doctrine, which he effects in the following manner:—

> "For it now appears to be conclusively established that the cell with its membranous wall, nucleus, and contents is no longer to be taken as the primitive type of organization; but that the nearest approach to this type is to be found in the segment of 'proto-plasmic substance,' or 'sarcode,' which forms the entire body of the lowest animals; and, further, that the portion of the fabric of even the highest animals which is actively concerned in nutrition, is a proto-plasmic substance diffused through every part, its segments being sometimes in continuous connection with others, sometimes isolated by the formation of cell-walls around them."

The author having thus given in his recantation, expresses his obligations to Dr. Beale, whose researches upon the structure and development of tissues have been the philosophic beacon which guided him through the mist in which he had previously existed. This is what surprises us most of all in Dr. Carpenter's treatise, for we fancy the writer has afforded but scant justice to one of our most able savants, whose opinions, nevertheless, he appears to have more fully adopted than those of Professor Beale. Why has Dr. Carpenter never mentioned the name of Thomas Henry Huxley in alluding to this subject,—a name which must live for ever in the annals of histology as that of the most formidable opponent the cell-doctrine has ever encountered? Twelve years ago Professor Huxley, single-handed, attacked the very foundation of the cell-theory. The doctrine was then in the zenith of its fame, and the difficulties which attended an onslaught on it were immense; yet, notwithstanding these circumstances, Professor Huxley's analysis of it must have convinced all unprejudiced minds that it was unworthy of support. It appears, therefore, to us a little unfair to give all the credit of conversion to Dr. Beale, who, though his investigations have been of the highest order, does not justly take precedence of the School of Mines Professor as the reformer of histological science. Further, it is not very easy to see in what Dr. Carpenter's present opinions (which differ certainly from Professor Beale's) are distinct from those of Huxley. The latter regards all tissues as being composed of two elements, *periplast* and *endoplast*. The periplast corresponds to the matrix or intercellular substance of other writers, and is the formative agent in the production of tissues; the endoplast (nucleus) is simply passive. Dr. Carpenter, on the other hand, employs the expression "proto-plasmic substance," but we very strongly incline to the supposition that this proto-plasmic substance is nothing more than the periplast of Huxley; and if so, Dr. Carpenter can hardly be justified in writing as though the idea of development which he conveys to his readers was really his own.

In regard to the improvements over other editions which the present one exhibits, we may mention that in most instances the text is in keeping with the recent advance in our knowledge of microscopic anatomy. A number of woodcuts from other treatises has been introduced, and the letter-press has been augmented by about a hundred pages. Still the old cell-idea pervades the entire book, and though unquestionably Dr. Carpenter has done his utmost to modify his former writing in adaptation to modern theories, the result is unsatisfactory; his volume presents a deal of ugly patching, which, under the circumstances, was unavoidable, but which will, we fear, prove exceedingly irksome to the student.

MEMOIRS OF THE ANTHROPOLOGICAL SOCIETY.*

SO much has been said about the Anthropological Society and the gap in science which its efforts were to fill, that the publication of its first volume of memoirs is a matter of interest to the general public. Some allege that this association owes its origin to pique, that a number of members of the Ethnological—a society of standing and respectability—who could not agree with the general body, determined to form an association for themselves; others contend that the Anthropologicals are atheists, whose whole aim is to crush Christianity, and substitute a wide spirit of rationalism. Whichever of these ideas be correct—and we do not vouch for the accuracy of either—the issue of the first volume of papers communicated to the society's meetings is of importance, inasmuch as it shows what work has really been accomplished, and enables us to judge as to how far the new body has fulfilled its extensive promises. Malicious "fellows" of the "Ethnological," with whom, of course, we have no sympathy, declare that an association which is presided over by Dr. James Hunt, and which delights in the worship of heroes of the Captain Burton stamp, could not produce, under the combined efforts of all its members, anything worth setting in type. Hitherto we have continuously abstained from offering an opinion upon the question, but now that the materials are in our possession, we do not hesitate to speak our mind, and we regret that we have not much to say in praise of the Anthropological movement. With regard to the propriety of forming an association for the study of mankind, when one already existed, we can only say that it was at least questionable. It is true that the President endeavoured to justify the founding of his society by an appeal to the relative significations of the words Ethnology and Anthropology. Such a method, however, is little better than mere quibbling, and is as unworthy of the chairman of (what we suppose should be termed) a learned body, as it is *de facto* unfair. Even if it is granted that the term Anthropology has a wider and less specific meaning than that of Ethnology, does such an insignficant circumstance warrant the division of a number of scientific men who, in order to obtain the best results, should work together? We fancy not. Doubtless the Anthropological Society will endeavour to prove that its aims are more comprehensive than those of the sister association; but its memoirs afford the best evidence on this point, and an impartial examination of them leads to a very different conclusion.

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* "Memoirs read before the Anthropological Society of London, 1863-4." Vol. i. London: Published for the Society by Trübner & Co. 1865.

In the volume lying upon our table we cannot find a single contribution of any value. We were about to say original contribution, but the expression would be out of place. Altogether the papers are very much of the sort that we find read before provincial literary and scientific institutions; they contain a very small amount of interesting matter spun out with considerable ingenuity, but they will never be referred to by anyone in want of information upon matters connected with Anthropology. Moreover, they are not essays which we should care to see our sons peruse with much interest. Although they cannot be said to be absolutely immoral, they in many instances border so closely upon the prurient that we are not surprised at the remark which one of them (written by that well-known supporter of all that is virtuous and ennobling—Captain Burton) opens with. In this the writer observes,

> "I cannot but congratulate ourselves upon the fact that we find in this room a liberty of thought and expression unknown, I may assert, to any other Society in Great Britain."

Thackeray tells us how certain old men, when the physical energy that once contributed to the ordinary gratification of their passions has been exhausted, delight to chat over the excesses of their youth; in fact, how to certain individuals the mere idea of peculiar forms of sexual indulgence is extremely gratifying. Such a mental condition is deplorable, even when confined to beings who may be said to live upon the edge of the grave; but how lamentable is the condition of things in which we find old and young engaged in the discussion of matters such as those which we have alluded to! Far be it from us to allege that this state is presented by the Anthropological Society, but it must, in all candour, be admited that some of its memoirs are more calculated to suit the palate of *l'homme blasé* than to engage the attention of the philosopher.

Of those articles to which, without offence to our readers, we may refer, the first and one of the longest is that upon the "Negro's place in Nature." This is from the pen of Dr. Hunt, the president; and is remarkable as the paper which was so painfully dissected by Mr. Huxley. In it the writer endeavours with a profound display, or rather what the general reader might mistake for a profound display of science, to prove that the negro is anatomically and mentally a being several degrees below the European. The great bulk of the article is composed of quotations; and this is perhaps fortunate, for Dr. Hunt is not happy in his construction of sentences, and is frequently unpardonably cruel to his "Murray:" the following passage to wit:—

> "Mr. Reade's observations and his description *does* (*!*) not quite agree with the accounts generally given of the negroes in the Bights or Windward."

The only memoir in the entire series which has a claim to be considered scientific is that by Dr. J. B. Davis, on the "Neanderthal Skull," a specimen which, though not in its possession, forms a great part of the Society's "stock in trade." It is a joint which the members have served up in every conceivable manner, and which they have succeeded in converting at length into a very vapid and unwholesome hash. Dr. Davis, who is only one of the hundred savants who have written upon this subject, attempts to show that the skull does not present race characters, but is simply an abnormally formed cranium. He supplies us with a *fricassée* of Mr. Turner's admirable article in the "Natural History Review," and tries to prove that the osteal conformation in the singular specimen under notice is the result of obliteration of the developmental lines. Apparently, considering that the gigantic frontal sinuses of the Neanderthal skull are characters of little importance, he confesses that he cannot advance a reason for their presence unless they are accidental. Whether Dr. Davis merely desired to *read* a paper or not it is not given us to judge, but we will not do his reasoning powers the injustice to think that he regarded his conclusion as a sound induction. The other portions of the volume are unworthy of comment, and the best wish we can express for the Anthropological Society is that its present issue of memoirs may command a very limited circulation.

PRIMITIVE MAN.*

ALL of us are interested in knowing what were the habits of life and general characters of our early ancestors, and of late years the desire for information upon this subject has increased vastly. The literature of prehistoric man derived its first comprehensive contribution from Dr. Wilson; Sir Charles Lyell's work next appeared in the field, and now we find the distinguished president of the Ethnological Society presenting himself as a public instructor. We are glad that Mr. Lubbock has left for awhile the arena of technical science, not because we think he is better in his present capacity, but because he is an original observer, enthusiastic in his devotion to his pursuit, and capable of giving us the results of his inquiries in language which is as lucid as it is fascinating. There is another reason, too, why we are pleased to see the volume which he now addresses to general readers, and that is that we wish to see its author as thoroughly appreciated and admired by those external to scientific circles as he is by those within them. His book is a combination of reprints and original matter, and cannot fail to be of interest to both naturalists and archæologists. It differs from Sir Charles Lyell's treatise, in containing less geological matter, and in embracing a more comprehensive and accurate account of those deposits in which flint weapons have been discovered. Firstly, he treats of the use of bronze in ancient times, and the bronze age; then he passes on to the consideration of the stone age, of tumuli, the lake habitations in Switzerland, the Danish shell-mounds, North American archæology, cave-men, the antiquity of the human race, modern savages, and, finally, he concludes with a most philosophic and deeply-thought dissertation upon the primitive condition of man, and the advantages of science. Not having space enough to review Mr. Lubbock's book, we must content ourselves with a few extracts from those portions of the text which strike us as most interesting. *Imprimis*, we must state that the author's classification of pre-historic ages is somewhat different from that usually adopted. He divides pre-historic archæology into four great epochs:

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* "Prehistoric Times, as illustrated by Ancient Remains, and the Manners and Customs of Modern Savages." By John Lubbock, F.R.S., &c. London: Williams and Norgate. 1865.

> "*Firstly*, that of the Drift; when man shared the possession of Europe with the mammoth, the cave-bear, the woolly-haired rhinoceros, and other extinct animals; this we may call the 'palæolithic' period. *Secondly*, the later or Polished Stone age; a period characterized by beautiful weapons and instruments made of flint and other kinds of stone, in which, however, we find no trace of any metal excepting gold, which seems to have been sometimes used for ornaments. This we may call the 'Neolithic' period. *Thirdly*, the Bronze age, in which bronze was used for arms and cutting instruments of all kinds. *Fourthly*, the Iron age, in which that metal had superseded bronze for arms, axes, knives, &c.; bronze, however, being still in common use for ornaments, and frequently also for the *handles* of swords and other arms, but never for the blades."

Mr. Lubbock does not appear to agree with those who think that stone, bronze, and iron weapons were in all periods of man's history used contemporaneously, and he brings forward powerful arguments in opposition to this creed. "Conversely," says he, "as bronze weapons are entirely absent from the great 'finds' of the iron age, so iron weapons are equally wanting in those instances where large quantities of bronze tools and weapons have been found together." That the art of working in bronze had reached a very high degree prior to the introduction of iron is evident from the numerous sketches of beautifully designed swords and daggers which adorn the pages of Mr. Lubbock's book. It is strange too to find what a similarity there is between the weapons of different nations which could have had at the period no connection with each other. This is especially striking in the case of the Danish and Irish 'Celts,' which seem as though they had been cast in the same mould. In touching upon the gravel deposits of the valley of the Somme, our author concludes that they afford proof of the existence of the human race at the time of their formation; and although he questions the authenticity of the Moulin-Quignon jawbone, he considers that the reason why human bones are absent from these deposits is not because man did not then exist.

> "No bones of men have up to the present time been found in the strata containing the flint implements. This, though it has appeared to some so inexplicable as to throw a doubt on the whole question, is on consideration less extraordinary than it might at first sight appear to be. If, for instance, we turn to other remains of human settlements, we shall find a repetition of the same phenomenon. Thus, in the Danish refuse heaps, where worked flints are a thousand times more plentiful than in the St. Acheul gravel, human bones are of the greatest rarity. At this period, as in the Drift age, mankind lived by hunting and fishing, and could not, therefore, be very numerous. . . . So far as the drift of St. Acheul is concerned, the difficulty will altogether disappear if we remember that *no trace has ever yet been found of any animal as small as man*. . . . When we find the remains of the wolf, boar, roe-deer, badger, and other animals which existed during the drift period, then, and not till then, we may perhaps begin to wonder at the entire absence of human skeletons."

Mr. Lubbock is a firm believer in Darwinism, and consequently he believes that early mankind must have been animals whose habits approached very closely those of the monkeys. The simpler arts and implements have, according to him, been invented independently by each race, and are but slight indications of advance upon the intelligence possessed by the Quadrumana.

> "Even at the present day we may, I think, obtain glimpses of the manner in which they were or may have been invented. Some monkeys are said to use clubs, and to throw sticks and stones at those who intrude upon them. We know that they use round stones for cracking nuts, and surely a very small step would lead from that to the application of a sharp stone for cutting. When the edge became blunt it would be thrown away and another chosen; but after a while accident, if not reflection, would show that a round stone would crack other stones as well as nuts, and thus the savage would learn to make sharp-edged stones for himself. At first, as we see in the drift specimens, these would be coarse and rough, but gradually the pieces chipped off would become smaller, the blows would be more cautiously and thoughtfully given, and at length it would be found that better work could be done by pressure than by blows. From pressure to polishing would again be but a small step. In making flint instruments sparks would be produced; in polishing them it would not fail to be observed that they became hot, and in this way it is easy to see how the two methods of obtaining fire may have originated."

Short as is the foregoing paragraph, it contains a vividly coloured picture of the possible habits of primitive man, and it is not too much to say of it that it is as plausible as it is clearly the result of matured thought and philosophic induction. It gives, too, better than any other quotation we could have selected, an idea of Mr. Lubbock's pleasing style of diction, and of the interesting character of his book. The volume is well and profusely illustrated, and will amply repay those who peruse it.

THE MICROSCOPE.*

No country has yet been able to compete with this in the manufacture of first-class achromatic microscopes. The German, French, and American instruments are all good of their kind, but none of them equal, in point of mechanical solidity, optical power, or clearness, those of the first London makers. Some attribute this to the greater love of microscopical research which Englishmen display; but such a notion is, we fear, incorrect. It may be due to the greater wealth of this country which enables us to encourage those who spend their energies in the improvement of microscopical apparatus, or the superior mechanical skill of English artisans may be the cause; but to whatever it is attributable, the result is unquestionable that our microscopes are superior to the foreign ones. Conspicuous among those who have taken the lead as microscopic opticians stands the firm of Smith, Beck, and Beck. These makers have been awarded an infinite number of medals and certificates for the cheapness and excellence of their instruments, and all those who are familiar with their manufacture must admit its high merit. Some years ago, when the public had to choose between an inferior instrument at a low price and a first-class one at a very high cost, microscopic pursuits were rather unpopular, and the microscope was a sort of curiosity to be found only in the study of the physician or the laboratory of the philosopher. At this period Messrs. Smith and Beck stepped into the field, and endeavoured to supply the "happy medium" in microscopic apparatus, which should make histology a popular study. With what success their efforts were attended all those who know anything of microscopy are well aware. For years past these makers have supplied the public with instruments which, while sold at a low price, fulfil all the wants of the student and the original investigator. They have not sought by an undue appeal to lacquer, and clap-trap appliances to catch the eye of the amateur, but have been, as far as our experience enables us to judge, desirous of furnishing sound and useful apparatus at a cost which leaves them fair remuneration. Although their "universal" microscope is one we do not much admire, there can be little doubt that their "student's" instruments are all that can be desired for the purposes of ordinary investigation. The book which Mr. R. Beck has written is little more than a very handsome catalogue of microscopes and their appliances sold by the firm, and although it must not be regarded as a treatise on the microscope generally, it will be found exceedingly useful as a book of reference by all those who employ Messrs. Smith and Beck's instruments.

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[*] "A Treatise on the Construction, Proper Use, and Capabilities of Smith, Beck, and Beck's Achromatic Microscopes." By Richard Beck. London: Van Voorst. 1865.

FROST AND FIRE.*

THE relation between force and matter forms one of the most interesting problems for solution by the philosopher. Indeed, the investigation of force, with a view to discover whether matter has any existence, is an inquiry of the highest interest. There appears to be good reason for the supposition that either of the two has only an abstract being. If, for example, we in imagination remove all force from anything which we call matter, we shall find there is nothing left. Let us deprive a common stone of the light-force which gives us a retinal sensation, and of the mechanical force which gives to our tactile sense the materials for an idea, and what becomes of the stone? If, then, we regard all phenomena as simply the manifestation of force, our studies must be confined to force alone. This would appear to be the change which our modern natural philosophy is passing through. Grove's admirable essay upon the correlation of the physical forces was the first dawning of enlarged views in physics. To it, we may say, that we owe the knowledge that all forces are convertible, and that heat, light, electricity, magnetism, and mechanical power are all the result of the operation of one force which pervades the universe. After Grove's essay came Tyndall's grand treatise upon heat as a mode of motion, and now it is pretty generally believed that all varieties of force have a common basis. The author of "Frost and Fire" has chosen a sublime subject for his work, but we fancy he has not dealt with it satisfactorily. Those who are ignorant of geological physics would hardly have imagined the nature of the work from its title, yet the latter is well and aptly chosen. Frost and fire, the two extreme exemplifications of the most powerful form of force, have had much to do in shaping out our globe and giving it its present form. The causes which operate in the formation of sedimentary rocks would, if left entirely uncontrolled, result in rendering the surface of our globe a perfectly level one. They are, however, counteracted by the effects of "fire," or volcanic force, which tilts up the surface into mountains, and by "Frost," which, in the production of glaciers, grooves out these mountains into ravines, chasms, and lake-basins. These effects of frost and fire are well demonstrated and explained in Mr. Campbell's volumes, and are illustrated by the writer's sketches, which in some instances are very prettily executed. There is nothing in the pages before us which has not been put before our readers in a thousand different ways before, but the author is original in his style, and if we think that he has not arranged his matter in a sufficiently systematic manner, we admit that in doing so he has made it more readable than it would otherwise have been, and most persons will forgive him on that score. There is, however, one fault of which he has been guilty, and which is less excusable, and that is the adoption in some parts of his work of a series of symbols descriptive of form. It may have exercised Mr. Campbell's ingenuity pleasurably to design a number of hieroglyphics significant of shape and outline, but it must be confessed that the introduction of them is anything but agreeable to the reader. The observations in the preface convey some idea of the character of the writer's production :—

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* "Frost and Fire. Natural Engines, Tool-Marks, and Chips: with Sketches taken at Home and Abroad." By a Traveller. 2 vols. Edinburgh: Edmonston & Douglas. 1865.

> "The following pages are meant for readers who take pleasure in natural science, without being philosophers. They are records of things seen or learned, and of thoughts which sprang up while scenes were fresh, or knowledge freshly gained ; they are written by one who has no claim to scientific knowledge, and they are printed for people like himself. A traveller's book is not for learned professors, but for that vagrant class who wander and think for themselves—who think of something besides daily bread or daily turtle and champagne, how to get ease and plenty, and how to get rid of time."

"Fire" occupies the least portion of the writer's book, which may indeed be said to be a voluminous popular essay on ice and ice action. We follow Mr. Campbell from the Alps to Norway, Scandinavia, Spitzbergen, and Iceland, and as we travel with him we pause beside some huge glacier, or boulder, or moraine, and listen to his pleasant story of its history and origin. In every instance we learn some new fact in physical science, and although our teacher has a quaint and somewhat humorous mode of expressing himself, still his power, as an instructor, is all the greater from this circumstance ; for we cannot listen without remembering his words, and as we accompany him on his wanderings we "cannot choose but hear." Let us see how he illustrates the action of icebergs in producing deposits of gravel, such, for example, as those of the Somme valley :—

> "A plate of ice, loaded with sand and loose stones, must drop its load in the same way whatever its dimensions may be. In a small plate the ice gradually melts, and mounds of sand form themselves into conical heaps on the wet surface. But as the ice-raft melts it loses its power of flotation, and it becomes lop-sided; one edge sinks and the flat surface becomes a sloping plain. It slopes more and more as the ice melts, till the slope becomes so great that the deck-load slips and rolls to one side and sinks the sunken edge still more. Then the mounds slip and become avalanches, slide overboard, sink to the bottom, and become mounds there. But while rubbish is shot one way the float shoots in the opposite direction, and the rest of the deck-load is washed overboard as the raft slips through the water. Ice, relieved from weight, bobs up like a board and shoots off edgeways, because there is least resistance in that direction. When rubbish-heaps are thus shot eastward, flat ice shoots westward, and the rubbish at the bottom is deposited as a mound with a tail stretching westward."

English, Irish, and Scotch glacial geology also receive Mr. Campbell's attention, and his observations on this branch of his subject should be carefully read by scientific tourists. The publisher deserves much praise for the excellent manner in which the volumes have been executed, both in regard to printing and illustration ; the binding is quite peculiar, the covers being so arranged that they exhibit, in "relief," the ice-markings which are seen upon certain rocks in St. John's, New Brunswick.

OPTICAL DEFECTS OF THE EYE.*

THE literature of ophthalmology will soon be something ponderous. Here is another treatise upon eye-surgery. It is written by Mr. J. Z. Laurence, one of the surgeons to the Surrey Ophthalmic Hospital, and a gentleman well known for his devotion to this department of surgery. The volume is not pretentious, and is little more than a reprint of lectures which some time ago appeared in the pages of the *Medical Times and Gazette.* It calls, therefore, for little notice at our hands. We like the method which the author has adopted in constructing his optical diagrams. The employment of cones of rays is a decided improvement upon the old system, under which either the axis of the pencil or the extreme ray was alone represented. If all writers upon optics would pursue the plan Mr. Laurence has followed, 'twould be an intense relief to the unhappy student. It seems to us that in some cases the author is rather too forcible in his denunciations of views from which he differs. We cannot at all agree with him in saying,

> "The theory that the cornea changes its convexity is one of those traditions that, devoid of all demonstrated truth, *has* (*sic*) still retained its hold on some conservative minds."

His explanations of the abnormal conditions, known as myopia, hypermetropia, presbyopia, asthenopia, and astigmatism, are, so far as we have been able to examine them, clearly and accurately rendered. Whether Mr. Laurence's treatment is in every instance orthodox, of course time alone can determine. We wish his book all the success it deserves.

APPLIED GEOLOGY.†

TO those who fancy that Geology is a species of abstract science we commend the little volume which Professor Ansted has just given us. It is the report of a series of lectures which this eminent geologist delivered before the Society of Arts, and is written in the Professor's clearest style. Dividing his subject into six sections, the writer touches upon the several applications of geological knowledge to the arts and industry. First, we have a chapter on agricultural geology ; then we are told all about the science of and laws regulating springs and water-supply ; and, in the other "Lectures," we find discussed the subjects of clays, cements, artificial stones, building materials, minerals, coal, and mining. There is only one objection which we have to urge against this volume, and that is, it embraces too wide a range of subjects to admit of every one of them being satisfactorily treated. For example, the space devoted to agricultural geology is quite inadequate. This is much to be regretted, for there is no branch of geology which requires to be brought especially under the notice of the people so much as that which relates to agriculture. We do not find, either, that justice has been done to continental labours ; for the author appears to yield an implicit submission to the theories of Messrs. Lawes and Gilbert. When Professor Ansted comes to his own subject, the improvement is apparent. The chapters devoted to "cements," and to "minerals derived from stratified deposits," are full of instructive details. In concluding his useful treatise, the writer observes :—

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* "Optical Defects of the Eye, and their Consequences : Asthenopia and Strabismus." By JOHN ZACHARIAH LAURENCE, F.R.C.S., M.B. Univ. of London. Hardwicke. 1865.

† "The Applications of Geology to the Arts and Manufactures, &c." By Professor D. T. Ansted, M.A., F.R.S. London : Hardwicke. 1865.

> "There are other applications of geology that I have not brought under your notice in these lectures. Among them I would especially point out that one which has reference to the fine arts. I mention it now to remind you that the subject of applied geology is far from being exhausted ; that, in fact, I have only considered it in one aspect, and that the many-sided science that deals with the earth—its history, its structure, and its grand physical features, and the causes that have produced and are daily modifying these features—is no less calculated to interest the artist and the poet than the farmer and the manufacturer."

BRAND'S DICTIONARY.*

THIS is a new edition of an old and well-known encyclopædia. The publishers propose to complete it in twelve monthly numbers, three of which have already reached us. The contributors to the several scientific departments have been in some cases unwisely selected, and we are sorry to perceive that the subject of microscopy and microscopic science is entirely unrepresented. The articles too, if so the short paragraphs may be termed, are of very unequal value, some of them being exact and up to the time, and others being as unquestionably full of error and misstatement. The chemical portion appears to be fairly edited, and the same may be said of the botanical and mathematical sections ; but the biological division, which includes all the natural sciences except physical geology, is disgracefully imperfect. We do not use so strong an expression without just reason, as some of the quotations which we propose to offer will sufficiently prove. The article "Animal" is especially bad. The writer, in summing up the characters which serve to distinguish animals from plants, makes egregious blunders :—

"Animals . . . are always provided with a mouth and an internal digestive cavity, or canal," and "at all times in respiration exhale carbonic and absorb oxygen." Writing of the lower animals, "Such organisms are termed acrita, or protozoa, and include . . . . the *diatomaceæ desmidiæ*," &c.

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* "A Dictionary of Science, Literature, and Art," &c. Edited by W. T. Brand, D.C.L., F.R.S., and the Rev. George W. Cox, M.A. London : Longman & Co. 1865.

We should like to see the stomach and digestive cavity of the amœba or tænia, and it certainly upsets our ideas a little to learn that diatoms and desmids have as much claim to animality as infusoria and rhizopoda. Again, the writer, ignoring the researches of Huxley, Quatrefages, and others, asserts that aphides are remarkable for "a peculiarity of their generative economy, particularly described by Bonnet, and which consists in the first fecundation of the female influencing not merely the ova immediately developed thereafter, but those of the females resulting from that development, even to the ninth generation." Many other instances might be pointed to; but we shall content ourselves with the following:—

> Cercariæ. A family of *infusoria*, having an enlarged body with a slender tail-like appendage. The body of the true *cercariæ* of vegetable infusores is rounded; that of the zoosperms, or *animalcules* of the seminal secretion, is flattened.

We trust that the future numbers of Dr. Brand's dictionary may undergo such revision as shall lead to the prevention of blunders like those we have pointed out. So far as we have seen of the present issue, it is lamentably defective, and though some reviewers may be content to judge of the merits of the work from the formidable array of contributors which adorns its covers, we fancy that those who give themselves the trouble to dip into its pages will not award much praise to this new edition. As we have already observed, it contains articles of very unequal value; but had there been sufficient attention paid to the supervision of each department, the result would have been more satisfactory.

A YEAR-BOOK OF FACTS.*

A WORK like the German "Jahr-Buch," or the French "Annuaire," which would give in abstract a record of the various scientific discoveries made during the twelve months previous to its publication, would prove a certain success. It would be of immense service for the purposes of reference, and would be read with interest by those who are desirous of watching scientific progress, but have not the time to peruse a number of technical scientific periodicals. Such a book should not be carelessly compiled, nor could its materials be arranged by one individual, no matter how widely comprehensive his knowledge might be. The difficulties in arranging the materials would be to know what facts to reject, and how much space to devote to each of those selected from the great mass. We almost despair of ever seeing our ideal realised, and we must confess that Mr. Timbs's efforts do not give us much hope. His book is an interesting jumble of scientific abstracts; but there has been no discrimination exercised by the compiler. Subjects which ought to have been dismissed in a few lines have often whole pages devoted to them, whilst others, which could not be fairly dealt with in the space allotted to their discussion, are hardly mentioned. Altogether, however, considering the obstacles which he has had to overcome, Mr. Timbs has produced an instructive little volume, which we heartily welcome in the absence of a better one.

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* The Year-Book of Facts in Science and Art," &c. By JOHN TIMBS, F.SA. London: Lockwood & Co. 1865.

A MANUAL OF PRACTICAL THERAPEUTICS.*

THE study of the physician is how to cure diseases, and his practice is to make use of the knowledge he has acquired in this study. This might be expressed by saying that he studies and practises "therapeutics," since θεραπεύω signifies "I cure." But "therapeutics" is nowadays more commonly used, in a limited sense, to signify the knowledge of the effects of medicinal agents in removing disease. Mr. Waring has employed the title "Practical Therapeutics" to indicate the uses of medicines and some of the physical forces for curative purposes. Under the head of each remedy we find a list of the diseases in which it has been employed, with such comments added as the author deems necessary, these being usually of considerable value. Indeed, the work is evidently that of an industrious compiler, of both experience and discrimination. It can hardly serve to any great extent as a "manual" for the medical student, because of its disconnected form, and its use by him will, we fear, tend to make him a superficial observer of disease, contented when he has succeeded in curing it. But as a book of reference to the hard-worked practitioner it must prove very useful, provided he is well informed on the nature of diseases and their diagnosis.

PRACTICAL CHEMISTRY.†

ONE would have imagined there was already an abundance of works on practical chemistry in the market, and that there was no room for a new comer. There are still in use the excellent treatises of Fresenius, Bowman, Odling, Noad, Galloway, and the Giessen "Outlines," and now a new candidate for favour makes its appearance. The volume before us is published in Messrs. Chambers' series of educational works, and though far inferior to the admirable manual of the late Dr. Wilson, is still a useful addition to this branch of literature. The preliminary instruction which the author gives the student has not much merit, the description of the process of "decantation," for example, leading to a rather different idea of the operation than that which would be learned from laboratory experience. It is to be regretted also that the old symbols, equivalents, and terms are employed ; it must prove exceedingly troublesome to the student who is in attendance upon lectures on modern chemistry to carry on his practical inquiries under the old system. In regard to scientific accuracy we have no fault to find. The characters and reactions of substances seem correctly given, and the methods of analysis are unimpeachable, since they are—very slightly modified—those adopted in the "Giessen Outlines." We can recommend Dr. MacAdam's manual to first year's students.

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* "A Manual of Practical Therapeutics." By E. J. Waring, F.R.C.S., &c. Second edition. London: Churchill. 1865.

† "Practical Chemistry." By Stephenson Mac Adam, Ph.D., F.R.S.E., &c. Edinburgh: Chambers. 1865.

HOMES WITHOUT HANDS.*

WE have received the numbers of this work up to and including Part XVIII. ; but we reserve our notice of them till the volume has been completed.

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* "Homes without Hands." By the Rev. J. G. Wood, M.A., F.L.S. London : Longman & Co. 1865.

SCIENTIFIC SUMMARY.

AGRICULTURE.

The Food of the Cow, and its Milk.—That all secretions bear some relation to the food upon which the animal from which they are derived is fed is a physiological fact that can hardly be questioned. At the same time, we know that such relation is much less intimate than has been supposed, and refers merely to the constituents of the secretion in question. Thus, we cannot by any ordinary process of feeding develop in any special secretion a salt or organic principle which it does not usually contain. At the same time, if the food does not contain the materials from which the components of the secretion are formed, the latter will not be properly or normally produced. The feeding of cattle in large towns is a subject which is well worthy of scientific investigations, and we are glad to find that it has already been taken up by a writer in the *Veterinarian.* Although the author of the paper to which we refer (a lady well known in social-science circles) has not given as much careful study to the subject as we should desire, still her remarks are at least suggestive. She thinks that both the milk and butter which we who reside in the metropolis are supplied with might be much improved by a proper system of feeding cattle. In cows' milk, she observes, the sugar is deficient, thus accounting for its inferiority to human milk as a producer of heat. The water is also less than in human milk ; the butter and casein are more, and the salts are also in excess. Cows' milk is not unfrequently acid (!), especially when the animal has been stall-fed, while human milk is decidedly alkaline. "Bearing all these differences in mind, it appears to me that every condition indicated might be fulfilled, and that we should obtain a very good balance in the relative proportion of these essential elements in the milk, if we supplied the cow with the kind of food containing the sugar, the alkali, and the carbon." There are two matters to which we wish to call the writer's attention : Firstly. She has omitted to mention that human milk contains much more potass than that of the cow, and that, consequently, the latter, be it ever so rich, cannot be substituted advantageously for the former. Secondly. It is quite impossible that cows' milk can be acid when drawn from the animal. The development of acid is due to fermentation of the sugar, which becomes converted into lactic acid, and if this was present in any notable proportion, it would inevitably precipitate the casein.

ASTRONOMY.

Transit of Venus.—In a letter to Sir R. Murchison, Professor Airy recommends, as a point well worthy of the attention of the Geographical Society, and in reference to the proposed exploration of the Polar Regions, that the portion of the antarctic continent at which the next transit of Venus will be most favourably seen should be surveyed, in order to determine if a suitable station can be found, and which has the necessary climate and clearness of sky. There is no difficulty in respect to the northern stations at which it can be observed (which will be on the Atlantic seaboard or at Bermuda); but unless the proper locality can be found for the southern one in the transit of December 6, 1882, no use can be made of this rare occurrence in determining the distance of the sun. The point in the southern hemisphere is situated about 75 degrees of West Longitude and 65 of South Latitude. The only inquiry which need be instituted would be to determine whether such a station can be met with, and where the sun can be seen at two and eight o'clock (Greenwich time) at such a period of the year. The proposed expedition might, of course, include other objects, as geography, geology, hydrography, magnetism, and meteorology, and might lead to very important discoveries in those branches of science.

Distance of Moon.—Mr. Stone has calculated a new value of this important element from a comparison of the lunar observations made at the Greenwich and Cape of Good Hope observatories during the years 1856–1861, and which were taken with instruments of nearly the same optical power. He groups together the observations of the north and south limbs, being convinced that personal error exists in measuring the discs of the sun and moon. The final result obtained is, however, nearly identical with that lately obtained by Mr. H. Breen.

Sun Spot Period.—Professor Wolf, of Zurich, has undertaken the laborious work of determining the number of sun spots at the different periods when the planets, more especially Jupiter, are in perihelion and aphelion. In the year 1859 he expressed his opinion that Jupiter determines the leading character of the sun-spot curve, that Saturn causes small alterations in the height and length of the undulations, and that the earth and Venus determine the indentations of the curve. More recently, Mr. Carrington and Mr. De la Rue have returned to the same subject, and the latter, in conjunction with Mr. Stewart, has found that when "the sun or a part of the solar surface approaches a planet, the spots disappear, or the brightness increases." It is the intention of Professor Wolf to calculate for every five days a mean relative number of sun-spots during the period 1811—1865. He gives the results of a portion of his labours in showing the connection of the sun-spot period of 11,11 years with the revolution of Jupiter between the years 1805 and 1816. The numbers given are certainly very remarkable, for whilst only 21 spots were visible soon after the perihelion of Jupiter in 1809, 64 were seen in 1815 at the time of the aphelion. The progression of the numbers is otherwise very remarkable.

Occultation of Kappa Cancri.—It will be remembered that in an occultation of this star, it was observed to hang upon the edge of the moon for a moment, which could only be explained by supposing it to be double. On May 2, 1865, Mr. Dawes had a good opportunity of testing this ; but the disappearance of the star at the dark edge was instantaneous. No projection or clinging to the edge was noticed at the reappearance. The star was examined with powers 407 and 560 ; but although the definition and steadiness were very good, no elongation of its disc could be perceived.

New Planet.—The 83rd minor planet was discovered by M. de Gasparis, at Naples, on April 26, 1865, and has received the name of *Beatrix*, in honour of Dante.

Spectra of Nebulæ.—Professor Secchi, during the past winter, has examined the spectrum of the nebula of Orion, which he finds to agree with that found by Mr. Huggins in regard to the planetary nebulæ. He found that in the whole spectrum only three lines were seen, one coincided with the line F of Fraunhofer, and the strongest was situated between b and f. The group lies between the Sodium ray D and the Strontian blue line. The nebula is green, and the blue ray which coincides with F lies between the green and the blue. In reference to the absence of the dark line f in the star Alpha Orionis, Professor Secchi imagines that this may be a body intermediate between the perfectly formed stars and the nebulæ, as this circumstance agrees with the presence of the bright ray in the nebula. Mr. Huggins, however, is not of the same opinion, as the spectrum shows that its light comes from incandescent solid or liquid matter, and that it is the presence of bodies in its atmosphere which produces the dark lines. The absence of one of the lines only shows that a particular gas does not enter into the composition of its atmosphere, whilst the great number of lines proves that there exist as many elements as in the sun and brighter stars, and he therefore thinks that the absence of the lines of hydrogen does not place this star in a lower cosmical rank. In regard to the spectrum of the nebula of Orion, Mr. Huggins finds that, like the annular nebula of Lyra, and that called the Dumb Bell, it only gives three bright lines, showing that their light emanates from glowing gas. He thinks that the small intensity of their light is due to this, and probably also their strange appearance as "on account of the absorption by the portions of gas nearest to us of the light from the gas behind them, there would be presented to us little more than a luminous surface." No indication of a continuous spectrum could be perceived in any portion of the nebula ; but the four bright stars of the trapezium gave one, showing that they were composed of incandescent solid or liquid matter. If, according to Lord Rosse and Professor Bond, the bright parts near the trapezium are composed of star-dust, Mr. Huggins thinks that this may be due to separate, and perhaps denser portions of the gas, and that the nebula does not consist of an unbroken vapourous mass. The vast distances of the nebulæ can no longer be considered as tenable in respect of those nebulæ which give a gaseous spectrum, and Mr. Huggins thinks that proper motion might be successfully sought for among them. If the nebulous theory of Sir W. Herschel be true, we should expect as many bright lines in the nebulæ as there are dark lines in the stars into which they have been elaborated. Those nebulæ with nuclei may, however, be partly composed of solid or liquid matter; but Mr. Huggins thinks that the nebulæ which are not resolvable, and yet give a continuous spectrum, as the Great Nebula in Andromeda, are gaseous, which "by the gradual loss of heat or the influences of other forces have become crowded with more condensed and opaque portions." But in so far as his observations extend, he thinks that the nebulæ are altogether distinct from the cosmical bodies to which the sun and fixed stars belong.

Sun-Spots and Surface.—Professor Secchi gives the result of his experience on those subjects, particularly on the spot visible at the beginning of the year. He examined it with the help of a solar prismatic eye-piece of the form recommended by Sir J. Herschel, which he finds very conducive in preventing any fatigue to the eye, and one is able to see a great deal more than before. According to his idea, there is no uniform tint in any part of the surface; but an agglomeration of oblong and white bodies, being of very different lengths, and one-third or one-fourth of a second in breadth. It is very difficult, he says, to compare them to any known object; but the name of *leaves* is not badly chosen, only without their regularity and uniformity. These particles appear like oblong filaments, or like bits of wool of elongated form, which it is almost impossible to delineate. They sometimes agglomerate together so thickly as to constitute a continuing stream; they are generally broken, but are more apparent when the spot is large.. He compares the appearance of the solar surface to the sun shining on clouds in a valley, and observed from the top of the mountain. Professor Secchi thinks that the solar surface is really constituted like. our clouds, those in our atmosphere being watery drops or crystals; but in the sun they are of some other substance suspended in its transparent atmosphere. This is particularly seen in the dissolving part of a spot when the forms of *cumuli*, *cirri*, and *strati* in a cloudy sky are recognisable. What he considers most singular are the small bits of luminous photosphere in the middle of the nuclei. Sir J. Herschell thinks he has found out the nature of those *willow-leaves.* He considers them to be *permanently solid matter*, with a fibrous or filamentous structure, which are only loosely coherent, and which are drifted along by currents, by which they are either torn asunder or aggregated. The reason that they only are luminous he considers to be because they are solid, and float in gaseous or transparent liquid, or intermediate matter of immensely high temperature. The non-luminosity of the medium in which they float is quite accounted for by supposing it of colourless transparency, as colourless gases or transparent liquids give off no light from their interior. He illustrates this by bringing nitre to a red heat in a crucible, when the surface will appear uniformly bright, whilst if it emitted light from the interior, the deeper portion should appear the brightest.

Lunar Photograph.—A photo-engraving has been issued by Mr. De la Rue, which, although much of the half-tint is lost by this method, he thinks may be of considerable use, particularly in photographs of large dimensions, as it would give a permanent record of the surface. It varies from the picture of the sun given by the same astronomer, as in the present case it is printed as in the ordinary copper-plate.

BOTANY.

The Flora of Australia compared with that of New Caledonia.—In a most important paper upon the flora of New Caledonia, M. Brongniart, in comparing the results of his own observations with those of Dr. Hooker regarding the Australian flora, concludes that there is a marked resemblance between the plant-lists of New Holland and New Caledonia. The Australian character of the plants examined by him refers principally to the presence of several families or natural tribes, which are equally abundant in the two countries. Such are (1) the myrtaceæ with capsular fruits, of which there are twelve species common to both countries ; (2) the proteaceæ, the greater number of whose species are found both in New Caledonia and Australia ; (3) the epacrideæ, of which about fourteen species are common. The whole of the plants in the collection received by M. Brongniart were 1,700, arranged as follows :—

Dicotyledons.........	1,100	Phanerogams 1,300.
Monocotyledons ...	200	
Acrogens	150	Cryptogams 400.
Amphigens	250	

Vide *Comptes Rendus*, April 3rd.

Abnormal Structure of the Common Snowberry.—An abnormal form of the snowberry which lately came under the notice of Dr. M'Alister is regarded by that gentleman as a decided illustration of the law enunciated by Goethe, that all parts of the plant are modified leaves. When the specimen was first exhibited, the Doctor was struck with its appearance ; it exhibited a raceme of berries in different states of development, the two lower being crowned by a circlet of leaves. The plant belongs to the honeysuckle order, and has its sepals united to form a confluent calyx, the remains of which are persistent on the summit of the berry. In Dr. M'Alister's specimen, however, their place was taken by ill-developed lanceolate foliar organs. When first gathered, each berry was crowned by five leaves. These leaves were closely connected at the base, and their midribs seemed to be connected with the woody bundles on the outer coating of the berries.

> "They appear to me," says the writer, "to be a modified calycine whorl, which from their position form a striking illustration of the law of morphology, as established by Goethe, that all parts of the flower are modified leaves."

Our great botanist, Robert Brown, long ago pointed out a curious fact in relation to the ovary of this plant—that in the immature condition it consists of four cells, two of which are many-seeded and two single-seeded ; but in the mature berry there are only two loculi, which correspond to the one-seeded cells, as the many-seeded cells become undeveloped and abortive.—Vide *The Dublin Quarterly Journal of Science*, April, 1865.

Number of Useful Plants.—Some interesting statistics have lately appeared upon this subject. The number of useful plants has been computed to be 12,000, but it must be remembered that the researches which lead to this conclusion have only extended over certain parts of the world. There are no less than 2,500 known economic plants, among which are reckoned 1,100 edible fruits, berries, and seeds ; 50 cereals ; 40 uncultivated edible graminaceous seeds ; 23 of other families ; 260 comestible rhizomes, roots, and tubers ; 37 onions ; 420 vegetables and salads ; 40 palms ; 32 varieties of arrow-root ; 31 sugars, and 40 saleps. Vinous drinks are obtained from 200 plants, and aromatics from 266. There are 50 substitutes for coffee and 129 for tea. Tannin is present in 14 plants ; caoutchouc in 96 ; gutta-percha in 7 ; resin and balsamic gums in 389 ; wax in 10 ; grease and essential oils in 330 ; 88 plants contain potash, soda, and iodine ; 650 contain dyes ; 47, soap ; 250, fibres which serve for weaving ; 44 for paper making ; 48 give materials for roofing ; 100 are employed for hurdles and copses ; 740 are used in building, and 615 are known to be poisonous. According to Endlicher, out of 278 known natural families, there appear to be only 18 absolutely useless.—Vide *Cosmos* I. 283.

A New Species of Docidium from Hong-Kong is described by Mr. W. Archer in *The Dublin Quarterly Journal of Science*, No. XVIII. The frond is about five times longer than broad, and is stout ; the suture forms a somewhat prominent ring. The segments are about two and a half times longer than broad, slightly and gradually tapering, with four prominent transverse whorls of short stout hyaline quadri-partite spines, their points divergent and sub-acute, and with a fifth whorl just under the ends, of short, stout, sub-acute, simple spines ; ends broad and truncate. The terminal space in the *endochrome* is large, circular, and well-defined, and the active granules are very numerous. Mr. Archer has given it the specific name *Kayei*, in honour of the gentleman who first observed and sketched the specimen.

Is Desmarestia Pinnatinervia a Distinct Species?—Dr. J. E. Gray, who by no means gives up his attention exclusively to the study of animals, has a paper on the relations of this alga in the *Journal of Botany* for June. The specimen, which was forwarded from the coast of Cornwall, had been found growing from the root of a specimen of *D. ligulata*, near the Lizard. There is good reason for the supposition that *D. pinnatinervia* is but a broad form of the European *D. ligulata*. The Cornish specimen, Dr. Gray thinks, goes far to justify the theory ; for the specimens were found growing from the same root as the typical English form of *D. ligulata*, and if the frond is compared with the thin young state of that plant, and especially with the broad membranaceous variety of it found in Cornwall and on the west coast of France and Spain, there is no structural difference to separate them —the only real difference being that the frond is much wider and, for its size, comparatively thinner and more membranaceous. Dr. Gray is not inclined to regard it as a variety of *D. ligulata*, but as a particular development of some of the fronds of that species, for he has been infomed that it absolutely grows from the same root-disk, and that many of the roots have one or more such fronds developed along with the usual narrow state of that plant.

Our Colonial Cinchona Plantations.—Sir William Hooker, in his annual report of the progress of the Royal Gardens of Kew, states that most flourishing accounts of the cinchona plantations continue to arrive from India. In the Neilgherries, Sir William Denison asserts that though the county had in April last suffered from 112 days' drought, yet the cinchona plantations had not been damaged, and that the plants were being propagated at the rate of from 30,000 to 40,000 monthly. From Ceylon, Dr. Thwaites writes, that in September last he had 190,000 plants, the tallest six feet high, that applications had been received for 28,500 plants, of which 9,000 had been supplied, and that he expected to issue 20,000 monthly. Jamaica still needs a proper person to superintend a cinchona plantation. The capability of the island for its growth has been abundatly proved by Mr. Wilson of the Botanic Garden, who, under every discouragement, has planted out 400 plants in a suitable locality, which, however, being at a great distance from the botanic gardens require a good, resident, practical gardener for their superintendence and increase.

The Structure of the Vinegar Plant.—Many additions to our knowledge of this fungus have been made by Mr. H. J. Slack in his recent paper read to the Microscopical Society, and published in its proceedings. An examination of the vinegar plant with low powers shows no more than the micrographic dictionary describes, but if portions are carefully illuminated and viewed under a magnification of from one to three thousand linear, it will be found that the gelatinous matter, hitherto treated as structureless, contains millions of small bodies resembling the bacteria that occur in the pellicle of solutions set aside to develop infusoria. These bodies vary considerably in size, some not exceeding $\frac{1}{16000}$ of an inch in length, others twice as big or more. If stained with iodine, they sometimes become a little plainer; but the more delicate will not appear as beaded structures to an observer coming quite fresh to their examination. Mr. Slack does not consider that all are beaded, and some seem to be in an intermediate state. The number that can be made out will depend upon the time employed in the investigation, and in the course of a week or two the observer will be able to trace their structure to a sufficient extent to justify the belief that all either possess or tend toward the bacterium form. Mr. Slack believes the yeast plant is commonly associated with bacterium-like bodies, and, probably, when their number is moderate, they do not noticeably interfere with the various fermentations. In the vinegar plant they are so numerous as to suggest the idea that they play an important part in the complicated series of actions which the plant, as a whole, excites.

The Phenomena of Conjugation in Navicula Serians.—That indefatigable observer, Mr. H. T. Carter, describes the method of conjugation of *N. serians* in a late number of the *Annals of Natural History.* The process is divided into a number of stages, which are arranged numerically as follows:—(1.) Two frustules, varying a little in size, approximate themselves. (2.) They secrete a gelatinous substance around them, which becomes covered by a delicate pellicular membrane. (3.) The sarcodal sacs force open respectively their frustules through the fissiperating divisional line, and carrying with them their contents, now all undistinguishably mixed together, approach each other and unite into one spherical mass, called the spore or sporangium. (4.) The sporangium divides itself equally into two spherical sporangial cells, each of which forms around itself a thick opalescent capsule. (5.) The capsules respectively divide in their equatorial lines, and expose the sheaths of the sporangial frustules. (6.) The sheaths become elongated, and at the same time present thread-like rings on their surface, diminishing gradually in thickness toward each extremity, but in close approximation throughout, except at the middle, where there is an interval of about $\frac{1}{6000}$ of an inch between them, or three times the breadth of the neighbouring rings. (7.) The sheaths, elongating, carry out the ends of the capsules upon their extremities. (8.) The hemispheres of the capsules disintegrate into short fusiform, curved, thread-like filaments. (9.) The sheath is fully formed, and the sporangial frustule appears within it. (10.) The empty sheath presents a longitudinal dehiscent fissure, through which the sporangial frustule obtains its exit.

Baccillaria Paradoxa in Fresh Water.—The Rev. Robert C. Douglass writes to the Editor of the *Microscopical Journal* (April) to deny that the discovery of *B. paradoxa* in fresh water is a new fact, as announced in the previous number of that periodical. It appears that he recorded in 1851 (*Botanical Gazette*) the detection of this species in a gathering from ditches near the river, a short distance above the town of Stafford. He adds, too, that on more than one occasion, after the publication of that notice, he found baccillaria in gatherings from the same system of ditches and on both sides of the river. It is remarkable that, though Stafford is far from the sea, salt-loving phanerogams have been found in its neighbourhood—*e.g.*, *Glaux Maritima* and *Rumex Maritimus.* There are salt-works about five miles from the town, in the direction of the localities of these plants, but the district where Mr. Douglas found baccillaria is in the opposite direction and far removed from their influence.

Candidates for the Correspondent Membership of Botanical Section of Academy.—In the first rank was placed Hofmeister, of Heidelberg; in the second, De Bary, Asa Gray, Dr. Hooker, M. Parlatore, and M. Pringsheim. Hofmeister was elected by thirty-two out of forty-four votes, Dr. Hooker obtained nine, and Parlatore three.

CHEMISTRY.

An Easy Method of Preparing Oxygen.—A convenient method of preparing oxygen in large quantities being a desideratum, Herr Fleitmann describes a mode which he adopts, and which possesses much scientific interest. He was led to the process by observing that on heating a concentrated solution of chloride of lime with only a trace of freshly prepared moist peroxide of cobalt, the hyperchlorite of lime was completely decomposed into chloride of calcium and oxygen. Repeated quantitative experiments, the results of which he has lost, convinced him that the whole of the oxygen was evolved, and that only chloride of calcium and no chloric acid was formed. The evolution of oxygen commences at about 70° or 80°, and continues in a regular stream, with a slight frothing of the liquid. The action of the peroxide of cobalt in this case, it is clear, is exactly like that of nitric oxide in the manufacture of sulphuric acid. There is no doubt that several peroxides of cobalt with various proportions of oxygen exist. The writer's experiments have shown him that the proportion of oxygen in peroxide of cobalt is variable, and the simplest explanation of this process is that a lower peroxide abstracts oxygen from the hypochlorite of lime to form a higher oxide, which is again decomposed into a lower oxide and oxygen. The peroxide made use of in one experiment, may be employed again to decompose a fresh quantity of hypochlorite of lime. From one-tenth to one-half per cent. is sufficient to effect the reaction. The following are the advantages of Herr Fleitmann's method :—(1.) The evolution proceeds with extraordinary regularity, and the gas is collected with the greatest ease, which makes the process specially applicable as a lecture experiment. When the mixture has been heated to 70° or 80° the lamp may be removed, as the heat of the liquid will then be quite sufficient to carry on the reaction to the end.

(2.) The *whole* of the oxygen is obtained from the material, while only a part is procured by heating peroxide of manganese.

(3.) The process has the advantage of greater cheapness than when chlorate of potass is employed.

It is necessary to employ a clear solution of chloride of lime, as a thick or murky solution will froth over. The best method of making a clear and strong solution is by first extracting one portion of chloride of lime with water, decanting the clear liquor, and then making use of that to exhaust another portion of the chloride. In this way it is easy to get a liquor which will evolve from twenty-five to thirty times its volume of oxygen.—Vide *Annalen der Chemie und Pharmacie*, April.

Explosive Compounds of Magnesium.—In experimenting with magnesium, Mr. J. N. Hearder, of Plymouth, is said to have discovered some explosive compounds of tremendous power and striking peculiarities. He ignited a small portion (20 grains) of one of these compounds during a lecture which he gave at the Plymouth Mechanics' Institute, the instantaneous and dazzling effect of which upon the audience was like that of a flash of lightning. On causing two bars of magnesium to form the terminals of a powerful voltaic battery a most intense combustion ensued : one of the bars speedily became red hot, entered into ebullition, and then burnt so furiously that it became necessary to plunge it into water, to prevent its falling on the platform. In this process portions of the burning metal detached themselves, and floated, blazing, on the surface of the water, decomposing it after the manner of potassium, and liberating hydrogen, which also burnt.

Arborization produced by Sulphate of Copper.—Very beautiful arborizations may be produced by placing a few crystals of sulphate of copper in a very diluted solution of silicate of potash. This arborization is remarkable from the circumstance that it seems to reproduce in the silica solution the mossy appearance seen in agates. The stalks very often rise in the form of an arch ; this takes place when the solution is at a certain degree of saturation. If it is very dilute, the arborescence rises vertically, and in a straight line. If it is too concentrated no arborization takes place ; the sulphate of copper merely becomes covered with a black coating. But in a profusely dense solution a curious fact is observable. After the formation of the vertical stalks, fresh branches form on them, inclining horizontally at an angle, which is the same for all in the same solution. In solutions of different densities, the most concentrated gives to them the most acute angle. Of this phenomenon the following explanation has been advanced:—"The helicoidal form of certain fibres sufficiently indicates that they have been assisted in their development by the density of the solution; they then curve in the line which most easily enables them to overcome this resistance; but there must be another cause for those fibres which form an oblique line always equally inclined, for they evidently follow this direction on account of the slight resistance thus offered to their development. The reason for this appears to exist in a kind of invisible cleavage possessed by the solution. If it be admitted that this cleavage exists, according to a rhombohedral, as silica belongs to this system, all will be explained, for the edges, as well as the faces, of this form are inclined horizontally."—Vide *The Artizan*, April 1.

Nitrogen not an Element.—A very cleverly written pamphlet has just been written by Mr. Henry Kilgour, to prove that nitrogen is nothing more than an allotropic condition of carbonic oxide. His arguments, though exceedingly ingenious, and displaying a careful study of the subject, might, with equal force, be applied to prove that nitrogen is an allotropic form of several other compounds; and, for this reason, we think his conclusion is, to say the least of it, premature. There is, indeed, evidence of weakness in the case, in the circumstance that Mr. Kilgour does not rely upon a philosophic advocacy of his views, but adduces the opinion of Professor McCosh, of Belfast, that he has worked out his theory with much force of logic. As we do not propose to enter here into the discussion, we give beneath the arguments advanced by Mr. Kilgour. Granting, he says, that (1st) It is a common occurrence in chemistry that the same substance should exist in different states. (2nd). When existing in their different states, the same substance exhibits different properties or actions, there are the following facts in proof of his views:—(*a.*) The two substances possess the same fundamental nature or constitution, as proven by the sameness (1) of their atomic or combining weights or equivalents; (2) of their combining volume; and (3) of their specific gravity—there being, however, a slight difference between them as to the last. (*b.*) That this difference in specific gravity arises from carbonic oxide possessing somewhat more specific heat than is possessed by nitrogen, the effect of specific heat being to lessen specific gravity. (*c.*) That it is this difference in the specific heat of carbonic oxide and nitrogen that forms the fundamental cause, not only of their difference in specific gravity, but of all the other differences in their properties and actions. (*d.*) That there are numerous other cases in chemistry in which the same cause and the same results are exhibited, being classed under the names of Allotrophy and Isomerism. (*e.*) That heat is, or occasions, activity in matter. (*f.*) That in consequence of the greater specific heat of carbonic oxide, it is more active or mobile than nitrogen. (*g.*) That keeping in view the greater activity of carbon and its effects, the action of carbonic oxide and nitrogen will be perceived to be the same. (*h.*) More particularly, the flaming or burning of carbonic oxide—nitrogen not flaming nor burning so readily; the positive poisonousness of carbonic oxide—nitrogen being only negatively poisonous; and their formation of different compounds,—are differences that all arise from the same cause; viz. from the greater activity of carbonic oxide caused by its greater specific heat. (*i.*) That similar differences from the same cause are also found to exist in the action of other substances admittedly the same, and having a similar difference in their specific heat. (*k.*) That it is known that carbon and oxygen have a greater attraction for each other at high temperatures than they have for any other substance; and that high temperatures applied to certain substances, and especially to charcoal, deprive them of specific heat, and thus condense them. (*l.*) That it may, therefore, be inferred that carbonic oxide—a substance of a nature kindred to charcoal—has been subjected to intense heat or electricity, or to the long protracted application of a less amount of heat or electricity, whereby it has been deprived of a part of its specific heat and converted into nitrogen, while at the same time the unequal attraction between its elements, carbon and oxygen, was thereby developed permanently to the fullest extent, making their separation intensely difficult, and thus accounting for nitrogen not having been hitherto decomposed. (*m.*) That the similarity of the action of nitrogen and carbonic oxide cannot be traceable to the sameness of their specific gravity, for olefiant gas possesses the same theoretic, and almost the same actual, specific gravity, yet its action is entirely different. (*n.*) That on all these grounds we are forced to conclude that nitrogen is an allotropic state of carbonic oxide.—*Vide* Pamphlet, "Nitrogen shown to be Carbonic Oxide." London: Churchill.

A New Yellow Colouring Matter for Rosaniline has been obtained by Herr Max Vogel. When a strong stream of nitrous acid is passed into an alkaline solution of commercial fuchsine or pure rosaniline, a series of beautiful phenomena of colour are observed. The red colour, which is first produced, rapidly passes into violet; this in its turn gives a blue, which afterwards changes to green. When the green solution is allowed to stand for some hours it assumes a reddish-yellow colour of a very beautiful kind. The change may be accelerated by continuing to pass the stream of nitrous acid. The colour undergoes no further change, and on evaporating this solution on a water bath, a reddish-brown paste is procured, which becomes hard on cooling, and when powdered has a lovely cinnabar red colour. From the discoverer's analysis the formula would appear to be $C^{16} H^{9} NO^{6}$. It is curious that this new substance acts both as base and acid. It is sparingly soluble in dilute, and easily soluble in concentrated acids; very soluble in alkalis. It may be separated by acids from its alkaline solutions, in which case it floats on the surface of the solution in a floculent mass. It dissolves freely in alcohol, sulphide of carbon, chloroform, and ether, but water does not dissolve it.—*Vide* "Journal für Pract. Chem.," Vol. 94, p. 128.

Ammonia and Nitric Acids in Hail.—Professor Reichardt, who has discovered both nitric acid and ammonia in hail-stones, now gives us the numbers indicating the proportions in which these substances are present. In a million parts of hail he found 3·247 of ammonia and 0·526 of nitric acid. These determinations agree very closely with those of Boussingault, who found in a million parts of rain-water 2·08 of ammonia, and 0·83 of nitric acid. Reichardt has also determined the specific gravity of hail-stones. According to his observations there are two kinds of these bodies—one opaque, the other glossy and transparent; the former had a specific gravity of 0·9234; the latter, of 0·9285.—Vide *The Chemical News*, May 12.

Composition of Dry and Fossil Sepia.—M. Hosau has been investigating the composition of the ink-bags of Cephalopods, a subject which has already been taken up by other chemists. He obtained two of the ink-bags of the cuttle-fish, which were very dry and hard, and were said to be very old. The specific gravity of the mass was 1·275. It broke with a conchoidal fracture, and, when examined under the microscope, appeared as a black amorphous substance, which underwent no change of colour when treated with acetic acid, potash, or alcohol. It was readily attacked by strong acids, dissolving in nitric acids, to form a reddish solution. Chloride of sodium constitutes the largest mineral ingredient in this substance, whose organic composition in 100 pints is as follows:—Carbon 44·2, hydrogen 3·3, nitrogen 9·9, and oxygen 42·6.—Vide *Chemisches Central Blatt*, No. 11, 1865.

A New Solvent for Aniline Colours has been discovered by M. G. De Claubry. This gentleman, who has for some time past been experimenting, with a view to find some cheap substitute for wood spirit and alcohol, has discovered that a decoction of soap bark, or of Egyptian soap root, dissolves these colours admirably, and furnishes a solution which is in every way adapted to the requirements of the dyers. He has found, too, that the new solutions present uniform shades—a fact of no small importance.—Vide *Comptes Rendus*, T. ix., No. 13.

The Preparation of Litmus by a new process has been suggested by M. de Luynes. He derives the colouring matter from *orcine*. He mixes this substance with twenty-five times its weight of crystallized carbonate of soda, and five times its weight of water, with the addition of a quantity of liquid ammonia equal in weight to the orcine. The mixture is placed in an imperfectly closed mattrass. It is then heated to between 60° and 80° for four or five hours, and stirred from time to time. The resulting dark violet-blue liquid is then diluted with water, and has hydrochloric acid added in excess. The precipitated colouring matter, when washed and dried, is pure litmus.—Vide *Journal de Pharmacie et de Chimie*, March.

GEOLOGY AND PALÆONTOLOGY.

Irish Limestone Caverns.—At a late meeting of the Cork Cuvierian Society Professor Harkness, so well known for his investigations of Scottish rocks, announced the discovery of the bones of mammals in a limestone quarry at Middleton, co. Cork. The rock consists of the ordinary limestone of the district, in one part much fissured, and under this fissured portion there is a mass of brown clay, the thickness of which cannot be determined, as its base is not seen. This reddish-brown clay under the limestone is the deposit which furnishes the fossil bones, and which, doubtless, fills the space that was once a natural grotto. Besides the bones, which are in a fragmentary condition, there are also present teeth and antlers. The latter are much broken, and do not afford sufficient character to enable the species to be accurately determined. They seem, however, to belong to two forms, one of which had the beam and branches smooth and sub-compressed, features which indicate the antlers of the rein-deer; and the other with the horns rounded and rough, a form of surface which marks the antlers of the common stag. Of these antlers two portions which appear to belong to the rein-deer have been cut while in the fresh state; and the faces of the cuts being almost smooth, this cutting appears to have been effected by a fine regular-edged instrument rather than by a serrated tool. The leg bones which appear in this clay have all been broken, for the most part longitudinally, except the carpal and tarsal, and other small bones of the extremities. This longitudinal fracturing of the long bones of the leg is not known to occur in any mammalian remains which belong to a period previous to that where we have evidence of the existence of the human race; and these broken bones afford evidence of the occurrence of man, who, for the purpose of obtaining the marrow, divided them in the direction most available for this object. Besides the evidence afforded by the cut antlers and longitudinally divided bones, there are other circumstances indicating the occurrence of man in connection with these remains; one of these is the presence of charred wood, which is equally disseminated through the clay, with the bones and teeth. This charred wood is the remains of the ancient fires by means of which former former human beings cooked their food.

Eoozoon Canadense not a Fossil.—Scepticism sometimes leads to as great absurdities as credulity; indeed it is hard to say which of the two is preferable, when we only consider the extreme forms of both. We believe that when the discovery of the ornithorynchus was first announced, certain gentlemen in this country, who apparently knew more of Nature's powers than she does herself, contended that the strange creature was a manufactured specimen, and that those who believed in the existence of such a paradox were the dupes of impostors. It would seem as if the Eoozoon—whose animal characteristics no one who is capable of using a microscope or is familiar with animal histology should doubt—is about to have its fossil nature discredited, and so share the early fate of the duck-billed platypus. Two gentlemen have determined to enlighten us upon the subject of the characters of Eoozoon. A light from the "far West" is shed upon science by the discovery of Professors King and Rowney, of Queen's College, Galway, that the Eoozoon is nothing more than a mineral. We were about to express our surprise at the marvellous advance that the Irish are making in scientific pursuits, but we regret to think that the savans in question are both Englishmen. Their announcement of the discovery we have referred to is given by them in the following words, which we extract from *The Reader* of June 10th:—"For several weeks past we have been engaged in investigating the microscopic structure of the Serpentine of Connemara, in comparison with that of a similar rock occurring in Canada, which has attracted so much attention of late. . . . It is now our conviction that all the parts in the Serpentine which have been taken for the skeleton structures of a foraminifer, are nothing more than the effects of crystallization and segregation. . . . We purpose at an early period lay before the public all the evidences and considerations which bear us out in our present opinion." We await Professors Rowney and King's "evidences" in extreme anxiety.

A Word to Collectors.—Dr. P. Martin Duncan being engaged in preparing an appendix to MM. Edwards' and Haines' "British Fossil Corals," and Mr. Henry Woodward having also undertaken to prepare a monograph of palæozoic crustacea of the order *Eurypterida*, for the Palæontological Society, they beg to request the kind assistance of geologists, palæontologists, and private collectors generally throughout the country, in forwarding their labours, either by the communication of information as to localities, or by the offer of the loan of specimens for examination, &c.

Is there an Open Arctic Sea?—Sir Roderick Murchison, who answers this question in the affirmative, gives the following arguments in support of his opinion :—(1.) The fact has been well ascertained by Scoresby and others, that every portion of the floating pack-ice north of Spitzbergen is made up of frozen sea-water only, without a trace of terrestrial icebergs like those which float down Baffin's Bay, or those which, carrying blocks of stone and *débris*, float northwards from the land around the South Pole. (2.) The northern shores of Siberia tell the same tale ; for in their vast expanse the absence of icebergs, or erratic blocks, or anything which could have been derived from great or lofty masses of land, has been well ascertained. (3.) As a geologist, Sir R. Murchison could point out that this absence of erratic blocks in Northern Siberia has existed from that remote glacial period when much larger tracts of Northern Europe were occupied by glaciers than at the present day. (4.) The traveller Middendorf found the extreme northern promontory of Siberia, Taimyr, clad with fir trees, while the immense tract of country to the south of it was destitute of trees, showing a milder climate at the point of Siberia nearest the pole.—*Vide* "Report of Meeting of Geographical Society, April 10th."

The Eruption of Etna.—The fullest details which have yet been published upon the recent operations of this volcano, are given in a memoir laid before the French Academy by M. Fouqué, who watched the eruption from its commencement. The eruption was preceded by an earthquake-shock, which was felt with such intensity at Lavina, near Piedmont, that the people rushed from their houses, and remained in the open air during the night. It first exhibited itself in the form of flames, which were seen rising from the north-east of the mountain at a height of about 1,700 metres above the level of the sea. Up to four in the morning there were a few faint oscillations of the ground. As soon as the earth had opened the lava commenced running with great rapidity, and in two or three days it had covered a surface nearly four miles long, two miles wide, and to a depth of about from thirty to sixty feet. The ground upon which the lava first flowed had an inclination of about four or five degrees. After having travelled over this space and destroyed almost everything in the shape of vegetation in its passage, the current was met by the ancient cone of eruption, known as Mount Stornello. There it divided into two streams ; one flowed to the west of the cone, and moved very slowly ; the other passed to the east, and was precipitated into a deep and narrow valley of Colla-Vecchio, which lies between Mount Stornello and the chain of Serra-de-la-Boffa. At this height the lava was thrown from a height of 160 feet into the valley beneath, forming in this way a veritable cascade of fire. The valley soon became filled, but the burning stream continued to advance for a distance of about two miles, and was finally arrested by a mass of ancient lava known as Sciarra de la Scorcia Vacca, at a height of about

875 yards. Such was the position of the lava on the 6th of February last. Since then the eastern stream has been completely arrested. The western one, on the contrary, has continued its progress, and has divided into two narrow currents, both of which lie between Mounts Stornello and Crisimo. The point of separation of these two streams is at a height of 1,444 yards, and is consequently higher than the base of Stornello. The nearest of the two streams to the cone, to which M. Fouqué has given the name of Antonio, continued to flow up to the 21st of February, when it ceased at a height of about 1,130 yards. The other, which he calls Carmello, travelled on till the 25th of February, and ceased at a height of 1,300 yards. Although at the period when M. Fouqué wrote (March 10th) both streams had terminated, they still continued to spread laterally. Vide *Comptes Rendes*, March 20th.

Are the Flint Implements from the Drift Authentic?—A pamphlet has appeared from the pen of Mr. Nicholas Whitley, of the Royal Institution of Cornwall, in which it is attempted to be proved that the so-called flint implements are not the result of human workmanship. The writer's logic, which we can hardly approve of, has been pushed to the most extreme lengths. Although we agree with him in thinking that many of the so-called flint instruments are the result of natural operations, we are far from believing that all are spurious. We subjoin an abstract of Mr. Whitley's arguments:—

(1.) *The "implements" are all of flint.* The tools employed by men of the recognized archæological stone age are made of stones of various kinds, of which there are examples of serpentine, granular greenstone, indurated claystone, trap greenstone, claystone, quartz, syenite, chest, &c. Why, therefore, should the only weapons in the drift deposit be manufactured from flint solely?

(2.) *The "implements" are all of one class—axes.* Were they then a race of carpenters? Man is a cooking animal; and if ten thousand axes have been found, surely one seething-pot or drinking-cup ought to have turned up. He needs shelter, but no remnant of his clothing or hut has been found. Almost everywhere where there are chalk flints we find axes, and nothing but axes.

(3.) *There is a gradation in form* from the very rough fracture of the flint to the perfect almond-shaped implement. Let the most enthusiastic believer in their authenticity examine carefully the one thousand implements in the Abbeville Museum, and he would probably reject two-thirds as bearing no evidence of the work of man. But it would be impossible for him to say where nature ended and art began.

(4.) Some of the implements are admirable illustrations of the form produced by the natural fracture of the egg-shaped flint nodule.

(5.) It is supposed that these weapons were used for cutting down timber and scooping out canoes. But it should be remembered that the gravels in which they are found were formed during a severe Arctic climate, in which no tree but a stunted birch could have grown, certainly none large enough to form a canoe.

(6.) *Their number.* The implements are found by thousands in small areas, and in numbers quite out of proportion to the thinly scattered population that must have (if at all) then existed.—*Vide* pamphlet published by Longman & Co., 1865.

Ruskin on the Alps.—A series of papers upon the subject of the conformation of the Alps has appeared in the *Geological Magazine.* Mr. Ruskin's style, even when applied to his own subject, is frequently unintelligible, the writer appearing, in his effort to be thought original, to exhibit a contempt for everything approaching to clearness and common sense. We may remark that his essays on the Alps, though a little more comprehensible than his "Cestus Papers," in the *Art Journal*, are at times difficult to understand. However, we commend them to our readers' notice, as, though hardly scientific, they are certainly curious.

The Laurentian (?) Rocks of Connemara.—In the *Geological Magazine* for March last, Sir R. Murchison stated, among other things, that the serpentinous rocks of Connemara which contain Eoözoon are certainly of Laurentian age, and that long before other geologists had imagined it he had pointed out the fact. Strange to say, however, in the April number of the periodical to which we refer, the writer makes the following recantation :—"On reviewing my notes upon and sections of the Connemara mountains of Ireland (made in 1851) I am quite satisfied that the green serpentinous marble of that district in which a foraminifer, supposed to be *Eoozoon Canadense*, is found, is unquestionably of Lower Silurian age, and is not as was surmised it might prove to be, a true Laurentian rock." Sir Roderick does not consider that the presence of Eoozoon is any argument against his view, for it is known that a *Globigerina* which lived in the cretaceous age is still alive.

The burning Well at Broseley.—Mr. John Randall, F.G.S., writes to the *Geological Magazine* anent this extinct petroleum spring. The so-called burning well has ceased to exist for nearly a century. It was fed by a spring, and petroleum and naptha also found their way from rents in the rock into the water of the well. Springs of petroleum on a much larger scale are met with in the neighbourhood, and the yield of them was formerly much greater than at present. Many hogsheads from one of these were exported some years ago under the name of "Betton's British Oil." The rocks were tapped by driving a level through one of the sandstone rocks of the coal measures ; but these are now drained, and very little is found to flow from them.

The Origin of the Salt in the Dead Sea.—One of our most distinguished explorers of the Holy Land attributes the intensely saline character of the Dead Sea to the hill of *Jebell Usdum.* This is a huge ridge of salt, about a mile wide, and running N.E. and S.W. for a distance of three miles and a half, then due N. and S. for four miles further. It is situated near the southern extremity of the Dead Sea, and renders that portion of it much more salt than the northern portion. Further, Mr. Tristram thinks that it is the proximate cause of the saltness of the Dead Sea, the drainage to which has been dissolving away portions of salt, and carrying it to the Dead Sea ever since the elevation of the ridge of Akabah separated the latter from the Red Sea, or since the desiccation of the ocean, which existed to the Eocene period, presuming (which seems most probable) that the fissures of the Ghor were of submarine origin, and that the valley itself was, during the Tertiary period, the northernmost of a series of African lakes, of which the Red Sea was the next.—Vide *Geological Magazine*, June, 1865.

MECHANICAL SCIENCE.

Rock-Boring Machinery.—Mr. Downie has communicated to the Institute of Engineers, in Scotland, a paper descriptive of the various machines proposed and adopted for boring rock, either with a view of superseding blasting operations, or to take the place of hand labour in boring the blasting holes. The most novel and interesting part of this paper is the description of the working of the machine of Mr. G. Low employed at the Dublin Water Works. The peculiarity of this machine, which bores holes preparatory to blasting, is that the steam or air cylinder is stationary, the tool being telescopic. The tool is propelled by a self-acting arrangement according to the speed at which it is actually cutting. In trials it bored granite at the rate of fourteen and a half inches in seven minutes, and three inches in fifty-five seconds. The average rate at which it bores the rock at the Dublin Water Works Tunnel, Roundwood, is one inch per minute. The rock is composed of green hornblende, with white quartz veins, and is so hard that miners have sometimes used from twenty-four to thirty-six tools to complete one hole, twenty-four inches deep. The machine strikes 500 to 600 blows per minute on the boring-tool. The following table gives the results of a series of trials at Roundwood.

(1)	24½	inches in	11	minutes	10	seconds	... Two tools.
(2)	19½	„	14	„	0	„	... Two tools.
(3)	9	„	5	„	55	„	... Two tools.
(4)	4½	„	2	„	10	„	... One tool.
(5)	9	„	7	„	35	„	... One tool.
(6)	9	„	5	„	25	„	... One tool.

Mackay Gun.—A defect has been discovered in the Mackay gun under proof at Woolwich. One round was fired with a charge of 50 lb. of powder. The gun weighs 10¾ tons.

Adhesion of Locomotives.—Mr. Bridges Adams has invented a plan of increasing the adhesion of locomotives by the use of friction-wheels, transmitting power from the periphery of the driving-wheels. Thus, in an eight-wheeled locomotive, with the two centre pairs of wheels coupled in the ordinary way, friction-wheels are placed between the fore pair of drivers, and the leading-wheels and the back pair of drivers and the trailing-wheels. The whole weight of the engine is thus made available for propelling the train.

Cupola Furnaces.—At Messrs. Woodward's foundry in Manchester, the ordinary fan-blast for cupolas has been superseded by a steam jet, acting so as to produce a vacuum in the cupola. It is proposed also to surround the upper part of the cupola by the boiler supplying steam to the jet. The plan, as far as it has been tried, is said to have economised fuel, and to have produced better castings.

Wear and Tear of Steam Boilers.—We have received from Mr. F. A. Paget, C.E., a copy of a paper read before the Society of Arts on the wear of steam boilers, in which the entire series of complex causes affecting the durability of boilers are considered under the following heads:—1st, the direct effects of the pressure of the steam; 2nd, the mechanical effects of heat; 3rd, the chemical effects of the fuel; and 4th, the chemical effects of the feed-water. Under the first head, the dynamical action of the steam, exerting impulsive strains on the boiler, is insisted on. The remarkable phenomenon known as furrowing is traced to cross-bending action, arising most frequently from lap-rivetted joints. Under the second head, the relative heat-transmitting power of thick and thin plates is discussed, the verdict being decisively in favour of the latter, and several instances of deterioration are traced to imperfect conduction from excessive thickness of the plates. The influence of heat in reducing the ultimate strength of iron is considered, and it is suggested that there is a thermal elastic limit beyond which, after dilatation of volume, iron does not return to its original dimensions. This dilatation is compared with elongation by strains in excess of the elastic limit, and is suggested as the explanation of the phenomena of "burnt" iron. The action of the flame is described as causing the combination of sulphur and oxygen with the surface of the plates. The subject of internal and external corrosion is treated, with special reference to the peculiar form known as "pitting;" and, finally, legislative enactments and the hydraulic test are discussed.

Competitive Guns at Shoeburyness.—The following table gives the results of the trials of the 7-inch guns alluded to in our last:—

Elevation.	Name of Gun.	Mean Range in Yards.	Mean difference of Range in Yards.	Mean reduced deflection in Yards.
2 degrees.	French	1,386	35·4	0·6
2 degrees.	Scott	1,462	21·5	0·9
2 degrees.	Lancaster	1,455	27·3	1·9

Automatic Steering Apparatus.—Dr. J. P. Joule has proposed a method of automatic steering by means of a delicately suspended compound system of needles or magnetic bars, to the one end of which would be attached a bent wire, one of whose extremities would be immersed in a central cup of mercury, connected with one of the poles of a voltaic battery, and the other would dip in one or other of two concentric semicircular troughs of mercury that would be moved round to the right or left, according as the ship would turn in one direction or the other. The other pole of the battery would be in connection with a branched conductor, leading to two electro-magnets, the free wires of which would thus be put in connection with the semi-circular troughs, and according as the bent wire would be immersed in one or the other trough, one or the other electro-magnet would be excited, an armature placed between the electro-magnets would be attracted by one or the other of them, according as the wire would dip into the one semicircular trough or the other. This armature would, by means of levers, &c., open valves, which would allow steam to act on one side of a piston or the other, the piston being connected with the tiller. By moving round the commutator, the ship may be made to follow any required course.

MEDICAL SCIENCES.

Action of Sulphuretted Hydrogen on the System.—M. Demarquay, who has lately conducted some experiments to determine the action of sulphuretted hydrogen on the body, has discovered that when this gas is injected into the cellular tissue of an animal, it rapidly produces death, being absorbed by the blood. It is exhaled by the lungs, and may be detected in the expired air by means of lead test-papers. When a small dose has been administered, the elimination is slow, and inflammation of the lung-tubes follows; but with a large dose the animal is soon destroyed.

The Croonian Lecture was delivered this session by Dr. Lionel Beale, the subject chosen by the lecturer being the relation of the nerves to muscle and other tissues, the Professor's views regarding the mode of termination of nerve in muscle proving the most interesting part of his discourse. Muscle, as our readers are aware, is usually described as being composed of a number of ultimate fibres bound together in bundles. Between these fibres are found multitudes of blood-vessels and nerves, the former supplying the tissue with nutriment, and the latter conveying to it those nervous stimuli which call into action its peculiar property—contractility. Each muscular fibre is *presumed* to be composed of a quantity of rectangular particles arranged in rows, and enclosed within a delicate transparent tube, which is termed the *sarcolemma.* As we have already mentioned, the nerve-fibres may be easily seen (with the assistance of the microscope) travelling between the constituent fibres of a muscular fasciculus; but hitherto it has been impossible to say in what manner they terminate. This question of termination is an extremely interesting one, not only from a histologic point of view, but also because it refers to some of the highest problems in physiology. It is already known that there are many resemblances between the nervous and electric forms of force, and the manner in which the nerves terminate in the tissues would, if discovered, afford much greater evidence than that we have heretofore possessed, of the distinctness or identity of the two sets of phenomena—nervous and electrical. In conducting all operations with electricity, it is essential that the wires along which the current is conducted shall be so arranged that a complete circuit is established; were it otherwise, the phenomena required would not be exhibited. If the nerve-filaments do not form complete circuits in the tissues, it is evident that the variety of force *now* known as *nervous* will operate under different circumstances to those required for electric phenomena; hence, the analogy hitherto supposed would in great measure fall to the ground. The researches of Dr. Beale, however, demonstrate in the most conclusive manner that the nerves do not terminate in *ends* properly so called, but form networks of extreme minuteness, the inosculations being formed by the finest filaments of the tissue. Dr. Beale's results may be thus summed up:—

(*a.*) The ultimate nerve-filaments form net-works, and never terminate in ends.

(*b.*) They can readily be distinguished from filaments of connective tissue.

(*c.*) The nerves of muscle never penetrate the sarcolemma, as supposed by Kühne and others.

(*d.*) There are no such structures as unipolar nerve-cells ; all ganglion-cells are bi-polar, *i.e.*, have two nerve-filaments proceeding from them.

(*e.*) These filaments are coiled, one round the other, and proceed on leaving the cell in opposite directions.

(*f.*) The so-called dark-bordered nerve-fibres divide into the finer filaments.

Relation of Starchy Matter in Liver to Food.—This subject was fully discussed in a memoir written by Dr. Robert McDonnel, a well-known Irish physiologist, and read before the French Academy on the 8th of May last. The writer pointed out, among other peculiarities of the hepatic organ, that the quantity of amylaceous matter which it contains bears little proportion to the weight of the liver as compared with that of the body. The volume of the liver of the cat in a state of health, and fed on flesh, is nearly double that of the liver of the dog during the most active period of the digestive process ; nevertheless, the liver of a large cat which had been well fed possessed only about two-thirds of the starchy matter produced by the liver of a dog which had been fed on carrots and bread. Hence, it may be concluded that the saccharine forms of food give origin to the amylaceous matter much more easily than nitrogenous food. It is true, however, that the liver can prepare the amylaceous substance from the fibrine of the blood, the gluten of corn, and also from fresh-meat. "Contrary," says the writer, "to the opinion of an eminent physiologist, I am assured that there is no more starchy matter in the liver of animals fed on gelatine than there is in that of those which have been starved. It is evident, therefore, that the liver cannot convert gelatine into starch, and the same thing may be said of fat."

What are Renal Diseases ?—This question may fairly be asked, since the recent inquiries of M. Rombaud tend to show that what have always been regarded as morbid conditions of the kidney are in reality not so. This *savant* has drawn the following conclusions as to the nature of three forms of what are still termed renal diseases :—

(1.) Calculus, diabetes, and albuminuria are not diseases of the kidney.

(2.) The anatomical alterations which are found during post-mortem examinations of patients who have died of any of these affections are the consequence rather than the cause of the disease.

(3.) The etiology of these three diseases may be expressed in four words—alteration of the blood.

(4.) This alteration consists in the excessive production of uric acid, which, according to the conditions under which it is present, may act either on the glucose or the albumen of the circulating fluid, producing, sometimes gravel or gout, sometimes diabetes, and occasionally albuminuria.

The Result of Engrafting Animal Tissues.—A remarkable memoir, detailing the results of some curious experiments regarding the vitality of engrafted animal tissues, has been written by Signor Mantegazza. He has engrafted the organs of one animal upon the body of another with the most surprising consequences. Some of the tissues thus engrafted underwent fatty degeneration ; but others appeared to live as well in the new as in the old organism, being united in course of time to the new one by blood-vessels and connective tissue. In the frog the engrafted reproductive gland continued to produce zoosperms, and the stomach, after having formed vascular connection with the surrounding parts, produced mucus and gastric juice. The spleen can exist for a long while in the body of another animal, and may even increase in weight. The spur of a cock lived for a period of eight years in the eye of an ox, and acquired a weight of 396 grammes. Signor Mantegazza also engrafted pure fibrine, and saw it converted into pus, connective tissue, granular cells, and new vessels. By varying his experiments, and by studying the organizing process as exhibited by blood engrafted or arrested in a blood-vessel, he has been persuaded that the Berlin doctrine *omnis cellula ex cellula* is fallacious ; the fibrine is the important principle of the organism, and is the material employed to repair living tissues and organize them.

Food as a Means of Preventing Disease.—It seems not at all improbable that, as has been shown by Liebig in the case of plants, most of those diseases which we at present attribute to the presence of some morbid substance in the blood, are produced in the first instance by the absence of some of the proper constituents of the blood. The blood when abnormally composed will allow vegetable and other growths to take place in it, thus producing painful symptoms ; but if it contained its suitable components, it is most probable that it would be then enabled to resist the development of the materials we refer to. In the case of the potatoe disease, there can hardly be a doubt that the sap becomes deteriorated, owing to the absence of the proper proportion of potash, prior to the development of the oïdium which commits such ravages. The idea which we have given has not had many advocates in this country, and we are glad to find that Mr. Erasmus Wilson has in some measure lent his support to the theory. Although Mr. Wilson does not go as deeply into the question as we should wish, still he shows that food may well be employed not only in preventing but in curing disease. If, he says, it be admitted that food is the source of the elements of which the body is composed, what kind of body can be expected in the case of a deficient supply of food, whether that deficiency proceed from actual want, or from some perverse theory of refinement, founded on a false conception of the nature and objects of food, and ignorance of its direct convertibility into the flesh and blood of man ? We think Mr. Wilson is too determined a supporter of flesh-eating tastes. If he had his way, he would convert man into a decidedly carnivorous animal, and we do not think that either experience or an appeal to the anatomy of the human masticatory and digestive organs would bear out his views.—Vide "*On Food as a Means of Prevention of Disease.*" Churchill & Co. Pamphlet.

The Kola-nut as a Source of Theine.—Dr. Attfield, the director of the Pharmaceutical Societies' laboratories, has reprinted his memoir on this subject from the *Pharmaceutical Journal.* His analysis of this fruit showed it to contain about 2 per cent. of theine, whilst coffee contains only from ·5 to 2·0, and tea from ·5 to 3·5 parts in 100. The presence of theine, then, at once points to the analogy of the kola-nut, or at least of dried kola-nut, with coffee, tea, and two other similar but less common substances—Paraguay-tea and Guarana. Infusions of one or other of these vegetable products are used as beverages probably by three-fourths of the human race, and each contains the same active principle—theine. To these must now be added the kola-nut What theine really does for the system is not yet very well made out. Liebig thinks that it may aid in the formation of that substance a normal quantity of which is so necessary—namely, bile. Most chemists agree that it arrests that rapid consumption of tissue and consequent feeling of fatigue which we all experience when we work hard with mind or body. Whatever may be its exact office, its discovery in kola must greatly enhance its physiological interest, showing, as it does, that the instinctive desire for it in one form or other by Europeans, Americans, and Asiatics, is shared by the natives of Africa. The other constituents of the dried kola-nut also indicate that it has the character of coffee, though differing from that article of diet in some important respects. Thus, Dr. Atfield found few or no granules of starch in finely-powdered coffee, while the powder of kola is apparently half starch, the granules forming the prominent object enclosed by the brownish-yellow coloured cell walls of the tissue. Although kola in the dry state resembles coffee, it differs from that substance in not containing tannin, in possessing but little fatty matter, and in the presence of much starch. "Indeed, so far as the analysis indicates, if the fresh nut did not possess peculiar virtues, which apparently are lost on drying, it might be advantageously substituted by coffee." For when made into a beverage, it is thick and mucilaginous like cacao, but is tasteless and inodorous, and is not impaired in these respects by roasting. Subjoined is a tabular statement of its composition:—

Water	13·65
Cell wall and colouring matter	20·00
Starch	42·50
Volatile oil and fixed fat	1·52
Albumenoid substance	6·33
Gum, sugar, and other organic matter	10·67
Ash	3·20
Theine	2·13
	100·00 parts.

Does True Super-fœtation ever occur?—This question forms the subject of a very able pamphlet, the report of a paper read some time ago before the Obstetrical Society of Edinburgh by Dr. George Lindsay Bonnar. It would be impossible for us to enter into the details of the cases cited by the writer; but we must confess that although he has not convinced us that super-fœtation in the strict sense is a genuine phenomenon, he has brought such a powerful weight of evidence to support the cause he pleads, that he has considerably shaken our scepticism. His essay contains an immense amount of information upon the important question it treats on, and cannot fail to be be of great interest to all medical readers.

Food in its Relation to Work.—The labours of the Rev. Dr. Haughton are already familiar to the readers of the Popular Science Review. A new exponent of the relation of food to work appears now in the person of Dr. Lyon Playfair, who has been lately lecturing in Edinburgh, and at the "Royal Institution," upon this subject. We have now before us a full report of his lecture, and though we cannot afford space for an analysis of his arguments, which we may remark are in some instances open to question, we give our readers a few of his results or conclusions. The following is his table of the diet required by several classes :—

	Subsistence Diet.	Diet in Quietude.	Diet of Adult in full health.	Diet of active Labourers.	Diet of Hard-worked Labourers.
	ozs.	ozs.	ozs.	ozs.	ozs.
Flesh-formers...	2·0	2·5	4.2	5·5	6·5
Fat...............	0·5	1·0	1·8	2·5	2·5
Starch	12·0	12·0	18·7	20·0	20·0
Starch equivalents (as heat producers) ...	13·2	14·4	22·0	26·0	26·0
Carbon	6·7	7·4	11·9	13·7	14·3

With regard to the exact value of the two orders of food, Dr. Playfair considers that Liebig is amply justified in viewing the non-nitrogenous portions of food as mere heat-givers. They never can act vicariously for albuminous bodies as tissue formers, although tissues may and do evolve heat by transformation when required to do so. That heat-givers do operate indirectly on the waste of tissues cannot be questioned. They facilitate transformation by keeping up animal heat, and by the promotion of the circulation. Cold-blooded reptiles become more active when warmth is supplied to them, and conversely, warm-blooded animals become more sluggish when the heat of their bodies fall, as during hibernation. "Such dependencies of different groups of food, acting co-ordinately, are incessantly found ; but, nevertheless, each group has its own specific work to perform."

New Method of Examining Nervous Tissue.—M. Roudanovsky suggests the following mode of preparing specimens of nervous structure :—(1.) Prepare with Valentin's knife sections of the nervous tissue frozen at a temperature of from 10° to 15° Reaumur. (2.) Colour them by means of infusion of cochineal or carmine. (3.) Cover the pieces with Canada balsam, or a mixture of glycerine and isinglass. Although we do not see anything very strikingly novel in M. Roudanovsky's method, we nevertheless give some of the results of his observations :—

(1.) An examination of a transverse section of a nerve shows that the primitive element of the nerve is a tube with a pentagonal or hexagonal outline.

(2.) The walls of the nerve-tubes, which are composed of connective tissue, form a perfect net-work.

(3.) The wall-forming tissue gives rise to cavities, or reservoirs, by which the nutrient fluid is conveyed.

(4.) The isolated appearance of nervous tubes is an artificial phenomenon.

(5.) The axis-cylinders are coloured by the cochineal as well as the walls of the tubes ; the former appear as knotted fibres in the centre of the tubes. The writer in the *Microscopical Journal*, in commenting upon the above statements, considers that the method adopted by M. Roudanovsky probably tends "less to the distortion of structure than that used by other observers." In this we cannot at all agree with him. It seems to us that the process is an exceedingly objectionable one. All tissues—and especially nervous ones—contain water in large proportions, intimately associated with the other elements; this would expand during the act of congelation, and so would inevitably give rise to many of the curious "cavities" and "reservoirs" which the observer records.—Vide *Quarterly Journal of Microscopical Science*, April.

METALLURGY AND MINING.

Constitution of Steel.—It would appear that M. Caron's researches upon this subject, which have already been reported in this REVIEW, have been favourably considered by the Belgian Academy of Sciences. This scientific body has awarded a gold medal to M. Caron for his researches. M. Stas, who was one of the Committee appointed to inquire into the merits of M. Caron's essay, made the following comments, proving that he fully coincides in the views of M. Caron:—"Steel is essentially composed of iron and carbon, and owes its qualities or defects to two different causes—the state of the carbon in the metal or the nature of the foreign bodies with which it is united. Whenever steel is good, its carbon can, under the influence of tempering, combine with the iron and give a hard brittle metal, which the tempering renders supple and elastic. When steel becomes bad, after undergoing several heatings, it is due to its carbon having been burnt or separated from the iron, and tempering will not regenerate the combination. This separation is mainly due to the influence of the foreign bodies, more especially silicium. These bodies also give to the metal defects varying with their nature and the impurities they contain." In concluding his report, M. Stas passed a very high eulogium upon the labours of M. Caron.

Action of Sea-water upon Metals and Alloys.—That we are not idle at home as to investigations upon the above subject, ample proof is afforded by the experiments of Messrs. Calvert and Johnson. From repeated inquiries these gentlemen have been led to the following conclusions:—(1.) The metal now most in vogue for ship-building—namely, iron—is that which is most readily attacked by sea-water. (2.) This metal is most materially preserved from the action of sea-water when coated with zinc, and, therefore, it would amply repay ship-builders to employ galvanized iron as a substitute for the pure metal. (3.) The extraordinary resistance which lead offers to the action of sea-water naturally suggests its use as a preservative to iron vessels against the destructive action of that element; and although pure lead is too soft to stand the wear and tear which ships' bottoms are subject to, still, an alloy of lead could be devised to meet the requirements of ship-builders. The experiments which led to the foregoing conclusions were thus conducted:—Twenty square centimetres of each metal were taken and carefully cleaned, in order that the sea-water might have its full effect. Then, two plates of each metal were placed in separate glass vessels and immersed in equal volumes of sea-water. After one month the plates were taken out, and any compounds that had adhered to their surfaces having been carefully removed, were then dried and re-weighed and the loss estimated. Calculating the action of 100 litres of water upon one square metre of metal, the extent of alteration was found to be represented by the following figures :—

Metals.	Grammes.
Steel	29·16
Iron	27·37
Copper	12·96
Zinc	5·66
Tin...	1·45
Galvanized Iron	1·12
Lead	a trace.

Vide *Chemical News*, April 14th.

The Treatment of Sulphur Gold Ores.—Messrs. Crosby and Thomson, of California, have pointed out a new method of treating auriferous sulphurs. Observing that the difference between the assay value of gold ore and the quantity of gold extracted was not accounted for by the gold remaining in the tailings, these gentlemen have conducted a long series of experiments which have demonstrated that gold, if not volatile, is so nearly so that the practical working of it is the same as if it were. It cannot be denied that the sulphur carries the gold, and it is observed that these auriferous sulphates of iron, by some natural system, are nearer the surface the further north they are found. In the new process, the ore, after being crushed into a fine powder or sand, and being generally wet, is passed through a drying cylinder some ten feet long by three feet in diameter; the latter revolves on a hollow axle perforated, through which oxygen can be passed to perfect desulphurisation, caused by heating the cylinders to a dull red heat. The cylinders are inclined sufficiently to carry the ore through ; at the outlet the desulphurized ore falls into a receiver and the vapour passes out above it. As it travels upwards, it pases through spray which cools it and causes the deposition of the metal.

Breaking Rocks by Fire.—This method, which, according to historians, was the one employed by Hannibal in cutting his way through the Alps, has lately been employed at the Rammelsberg mines in the Hartz mountains. In a portable furnace, about 1½ bushel of coke is allowed to burn for thirteen hours, the furnace is then removed and the rock left to cool after being sprinkled with water. About noon the face of the rock spontaneously detaches itself, and after that a further portion is broken. The effects of the fire extend to eight inches, and with 1½ bushels of coke from 1,600 lb. to 2,400 lb. weight is obtained at half the cost of the gunpowder process.—Vide *The Artizan*, June, 1865.

New Process for the Manufacture of Zinc.—This, which has been patented by Mr. James Webster, of Birmingham, consists in bringing the zinc ore, or oxide of zinc, in a finely divided state, into the presence of molten iron or any substance which melts at a temperature higher than that of the volatilising point of zinc. He adapts to a cupola a vessel containing the pulverized-zinc ore, which, together with nitrate of soda also pulverized, is carried down a channel, and supplied in a regular manner to a close chamber, into which the molten iron is run from the cupola. This regulated supply of the zinc ore is effected by means of a rotating screw, which forces the pulverized ore forward into the molten metal, where it becomes volatilized by reason of the high temperature. From the close vessel the vapours are conducted through a pipe to a vessel containing water, where the zinc vapours are condensed and the metal precepitates. The close vessel, where the zinc is brought into the presence of the molten metal, will after a while become charged with slag, which must from time to time be removed. The nitrate of soda is used for the purpose of rendering the slag more liquid.

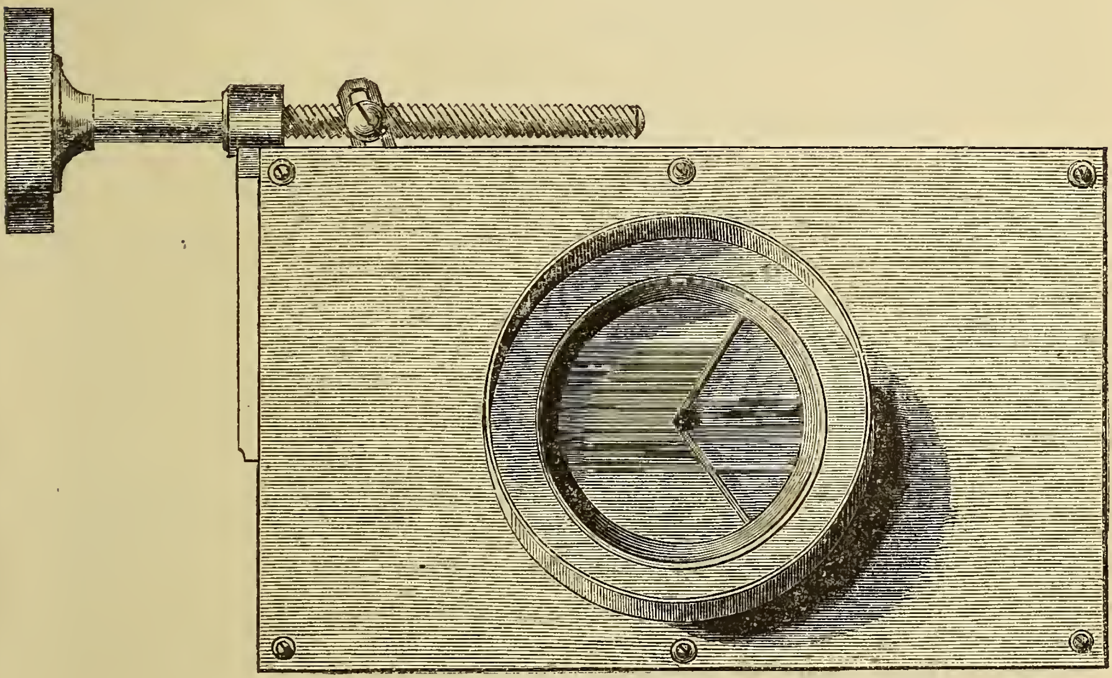
The Extraction of Silver from Lead.—An invention of a somewhat novel character for effecting the extraction of silver from lead has been brought forward by M. Millan, of Bordeaux. The lead from which it is desired to extract the silver is run from the reverberatory furnace into a heating-pan, under which a strong fire has been made, so that no cooling of the lead may take place, but that its temperature may become raised after a short time. The surface of the lead is then skimmed, after which the inventor introduces about one part, by weight, of carbonate of ammonia to every 100,000 parts, by weight, of lead contained in the heating-pan ; the carbonate of ammonia is introduced by means of a covered ladle perforated with small holes. This instrument, with the carbonate of ammonia therein, is stirred about in the lead for the space of five minutes, and is then re-inserted charged with one part of sea-salt to 10,000 parts of lead. This is stirred in for ten minutes, the quantity of sea-salt being increased when the quantity of silver contained is high. The skimmings are placed in heaps and afterwards heated in a close retort. One per cent. of zinc is then added in the same manner as the carbonate of ammonia and sea-salt, the mass being stirred for five minutes after each charge of zinc, until sufficient zinc has been introduced. The fire is then withdrawn that the mass may cool as quickly as possible. As soon as the surface is slightly crystallized, it is skimmed and retorted with the other skimmings, the silver being separated by distillation.

How to Detect Chromium in Iron, Steel, &c.—The following simple process for the detection of this metal in iron, steel, cast-iron, and ores has been given by M. A. Terreil in a late number of the *Bulletin de la Société Chimique.* Treat the metal or ore by the ordinary processes to separate the silica, and obtain a liquid containing all the metals in solution, and in which the iron is at its maximum of oxidation ; then precipitate the liquid by an excess of a very concentrated solution of potass. Next pour, drop by drop, into the solution containing the precipitate, and heated to 80° or 90°, a very diluted solution of permanganate of potass until the permanganate loses its colour ; the reaction is terminated when the liquid takes a greenish tinge, owing to the manganate of potash, which supplies no oxygen. Then filter, saturate the filterized liquid with acetic acid, which immediately reduces the small quantity of manganate of potass that gave the solution its green colour. Next pour acetate of lead into the solution which finally achieves the object desired by throwing down the chromium as a yellow chromate of lead. This process is equally applicable to the discovery of tungsten, vanadium, and molyldenum.

Galibert's Respirator.—This apparatus, which is intended to be employed by miners, well-sinkers, and sewer-workers has been lately tested, and shown to be a most valuable addition to our list of appliances. It is composed of three parts :—first, a piece of horn of the shape of the mouth when open, pierced by two holes. (2.) Two india-rubber tubes communicating with these holes ; and (3rd.) a nose-pincher, which prevents respiration through the nostril. The pincher being applied to the nose, the mouthpiece is held in the mouth by pressure of teeth, and the workman can then, by closing the expiratory hole with his tongue, draw in air through one tube, and then by placing his tongue upon the second hole he can breathe out foul air through the other tube. A second form of this invention differs from the first, in having the tubes communicating with a reservoir upon the workman's back. This is intended for the use of firemen and others who have, for a short period, to enter an atmosphere of foul air or smoke. The inventor also employs peculiar glasses for the protection of the eyes. This apparatus may be seen at the Polytechnic Institution.

MICROSCOPY.

A Graduating Diaphragm.—A very ingenious diaphragm has just been devised by Mr. Collins, of Great Titchfield Street. The advantages of the new instrument can only be appreciated by those who understand the necessity which exists for regulating the amount of light which is reflected from the mirror of the microscope upon the object under investigation. In the ordinary "wheel of diaphragms" there are about half a dozen apertures of different sizes, and the observer rotates the disk until he finds an aperture which admits the proper flood of light. There are, however, two serious objections to this method :—1st. As the number of holes is limited, the microscopist, though enabled to select the best aperture of the series for his purpose, may not be supplied with such an aperture as would give the exact absolute degree of illumination. 2nd. While rotating the "wheel" to obtain the required result he loses sight of his object, and thus is unable to perceive fully the advantage he has derived from the alteration. Both these disadvantages have been overcome in Mr. Collins' diaphragm, which provides a means by which any sized aperture may be obtained without removing the object from observation. The subjoined engraving explains the apparatus. It consists of a plate, placed beneath the stage, and having below it two smaller ones, whose opposite sides are incised in a cuneate manner, and which, when separated, leave a large lozenge-shaped aperture ; but, when caused to approach, gradually diminish this aperture till it is reduced to a mere point. The approximation and separation are effected by means of a screw, whose milled head is within easy reach of the observer's finger. This piece of apparatus may easily be appended to any microscope, and the manner in which it aids in the display of the striæ of enamel and muscular fibre, and the delicate markings of the diatomaceæ, must be seen to be fully appreciated. Obviously its greatest merit lies in the power which it gives to the observer of graduating his aperture of illumination with the greatest nicety, and of estimating the improvement in the definition of fine points of structure as he proceeds in his observation. It might appear at first that the lozenge-shaped aperture would interfere where certain varieties of illumination are required; but we think that this objection can only be urged in exceptional instances. For most of the purposes of research the new diaphragm is an immense improvement on the old one.



COLLINS' GRADUATING DIAPHRAGM.

A simple form of Achromatic Condenser, the invention, we believe, of Mr. Webster, and which was described some time since in *Science-Gossip*, is now undergoing certain modifications and improvements, which the manufacturer (Mr. Highley) thinks will render it equal in power to the common achromatic condenser, at a cost of about one-sixth of the latter. We have not examined the instrument ourselves; but from what has already been written, we apprehend that it is a combination of the Kelner eye-piece and parabolic illuminator.

A new mode of using the Lieberkühn is suggested by Mr. Keneely Bridgeman. "If," he says, "we cover up a portion of the reflecting surface of the lieberkühn, we shall be enabled to obtain any proportion of oblique light in one particular direction; and then, by rotating the Lieberkühn upon the object-glass, may bring it to bear upon every part successfully without having to alter the position of the object. In this way the most delicate structure, such as the barbs upon the very beautiful and nearly transparent spines of *Opuntia tunicata* which are scarcely to be detected by the whole light, may be brought out into full and bold relief."—Vide *Quarterly Journal of Microscopical Science*, xviii.

Abstracts of papers relating to Histology will be found under the following heads :—

BOTANY—

A new species of Docidium.
The Structure of the Vinegar Plant.

The Phenomena of Conjugation in Navicula.
Baccillaria Paradoxa.

GEOLOGY—
Eozoon Canadense not a fossil.

MEDICAL SCIENCE—
The Croonian Lecture.
The Engrafting of Tissues.
Method of Examining Nerve-tissue.

ZOOLOGY—
Anatomy of the Lower Echinoderms.
The Circulation of Blood in Spiders of Genus Lycosa.
The Nervous System of the Earthworm.

PHOTOGRAPHY.

The Photographic Exhibition.—The annual exhibitions of the London or King's College Photographic Society and that of the Architectural Union, have, for some years since, been pecuniary failures ; this year they combine their attractions, and we hope the result will be more satisfactory. The photographic collection was got together at less than a month's notice after the Society had announced the discontinuance of its annual exhibitions ; and much that is unsatisfactory to those who look to these yearly gatherings as representative of artistic and scientific progress may be fairly attributed to undue haste. Most of the productions lack the attractiveness of novelty, having been publicly sold and exhibited on many previous occasions ; and too many of them are uninteresting specimens of the portrait manufacture now carried out so largely throughout the kingdom, being such a collection of very ordinary *cartes-de-visite* as may be seen—unfortunately cannot be unseen—at nearly half the door-posts, and in nearly all the shop windows, in London. Most of the more eminent photographers are conspicuous by their absence ; and this is the more to be regretted, because their works are of such a character as would not only prove generally attractive, but would elevate the standard of general excellence, although we have one or two new names attached to productions of remarkable beauty, and new kinds of very attractive work from some old and well-known names. Among the former, that of Mr. Falkner, an artist and photographic portraitist of rapidly increasing reputation, takes the highest rank ; and amongst the latter Mr. V. Blanchard occupies a conspicuous place, by virtue of a series of pictorial figure-subjects, which are not less beautiful than the instantaneous sea and sky stereographs with which his name is popularly associated. Mr. H. P. Robinson exhibits some very charming portraits taken in diffused day and direct sun light. Of great technical beauty, these are sadly wanting in artistic feeling. The passion for giving sentimental names, with which they have nothing in common, to otherwise good photographs, merely to add adventitious interest to things already sufficiently interesting in their way, is a fault shared with Mr. Robinson by several other exhibitors ; but to call a life-study, after (a long way) Magin's "Reading Girl," "Brenda;" a group of common-place girls under an English hedge, muffled up in fantastically-arranged modern dresses; "Rebecca and her Maidens;" and a girl reposing under a nearly mid-day sun, "Evening!" is really too bad, however perfect such productions may be as photographs. Nor does the photographer benefit personally by such folly, for the observer cannot admire the talent displayed without also concluding that the exhibitor is either very ignorant or impertinently egotistical; either he does not, for instance, know that the sun-light falls at midday at one angle, and in the evening at another, or else he absolutely prides himself upon such school-boy knowledge as peculiar to himself, and has no fear of others detecting such a very glaring blunder. Some famous solar camera enlargements, life size, are exhibited by Mr. Alfred Harman. The exhibition also contains some admirable landscapes by Bedford, Mudd, Thompson, England, Blanchard, Annan, Gordon, Macfarlane, and others of our best landscapists, and several specimens of new printing processes in carbon, printer's ink, &c., on various surfaces. The specimens of apparatus shown are some stereoscopes by Murray and Heath, a graphoscope, and a very tastefully and highly finished piece of cabinet work, in the shape of a handsome cabinet stereoscope, in polished walnut-wood, by Mr. Meagher.

The Aniline Process.—This is a new process of printing, of a truly novel description, introduced by Mr. Willis. For rapidity and simplicity of working, and for cheapness of production, it is unequalled; but its applications are limited at present to the fac-simile reproductions of artists' drawings of every description, being very useful for reproducing large drawings such as engineers and architects produce, or the transferring of prints, photographs, old MS. music, maps, or artists' designs to the block, for wood-engravers. It will also be useful for decorators and photographic colourists. The sensitizing solution is as follows:—

Bichromate of ammonia	30 grains.
Phosphoric acid solution	1 fluid drachm.
Water	1 „ ounce.

The phosphoric acid meant is that sold in commerce under the name of dilute, and its strength should be such as will produce not a red or green, but a purplish black print. Plain Saxe paper is used, and the above solution is brushed evenly over its surface with a clean tuft of cotton wool. After it has been dried in the dark, it is exposed to light under a positive photograph or drawing, with which it is in close and even contact. When the image thus printed is distinctly visible, it is subjected to the action of aniline vapour, either by placing the proof fastened by wafers upon a plate of glass over a flat-bottomed porcelain dish, containing a sheet of bibulous paper, and about a drachm of the aniline, such as is commonly sold in shops, or by so placing the paper in the bottom of a box that the aniline vapour descends instead of ascending. If the completion of the development leaves the picture of a dingy buff or orange-colour, it may now be whitened by simple washing in plain water. The fixing is accomplished by placing it for a few minutes in water to which a few drops of sulphuric acid have been added, after which it is washed and dried.

The Eburneum Process.—During the past three months several other new processes have been wrought out and published; amongst them, that called the Eburneum, by which pictures possessing great brilliancy, softness, and perfection of detail have been secured. A mixture of gelatine and zinc white is prepared—gelatine 5 oz., water 20 oz., glycerine ½ oz., oxide of zinc 1 oz.,—adding the latter to a warm, and not too thick or hot, solution of the former, and mixing thoroughly, so as to produce an opaline effect. This is then put aside, and allowed to settle, and then carefully decanted into a clean bottle ready for use. A clean plate of patent glass is next rapidly coated with a saturated solution of the best white bees-wax in methylated ether, applied with a tuft of clean cotton wool. When the ether has evaporated, or, to use other words, in a few seconds, the plate is rubbed with a piece of clean linen kept for this purpose, until a scarcely perceptible coating of wax is on the polished surface of the glass. Another solution of 6 grs. of india-rubber in 1 oz. of benzole is next used, by dipping therein a camel-hair pencil, and passing it round the edges of the glass to the width of about one-eighth of an inch. The plate is next coated with some good negative collodion, giving a tough horny film, and immersed in the usual silver bath. On this the positive is printed in the camera, in the way usually adopted for obtaining transparent positives. The developing solutions recommended are the following—No. 1 for positives from vigorous negatives; No. 2 for use with weaker negatives:—

No. 1.

Proto-sulphate of iron	5 grs.
Citric acid	5 „
Glacial acetic acid	10 mms.
Water	1 oz.

No. 2.

Pyrogallic acid	3 to 6 grs.
Citric acid	3 „
Glacial acetic acid	20 mms.
Water	1 oz.

The development is conducted in the usual way, and the image fixed in a solution of cyanide of potassium, ½ oz. to a pint of water, after which it is subjected to a thorough washing for a quarter of an hour, and put up to dry in a place free from dust. If the plate is not a small one, slips of paper are next pasted round the edges of the glass, so that the edges stand up round above the surface, thus forming a kind of dish, into which, when placed on a levelling-stand, the gelatine and zinc-white solution is poured. When this has set, it is put into a box, having a covering of perforated zinc, in which it rests on nails in the sides. Gas or a spirit-lamp is applied, to subject it to a heat of about 60° to 70° Fahr., and it becomes hard and dry in about thirty-six hours. A coat of plain collodion or varnish is applied, and when this is dry, a penknife passed round the edges releases the whole from the glass plate, when the edges are trimmed and the picture complete,—the perfectly smoothed and polished surface given by contact with the glass being one of the reasons why the gradations and details are rendered so perfectly. We owe this process to Mr. J. Burgess.

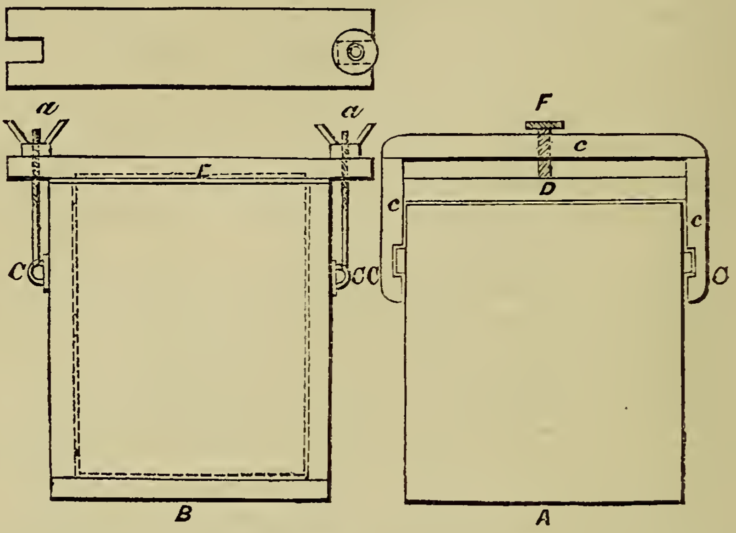
The Simpsontype.—Far more simple than the preceding, this process gives results no less beautiful. A collodion, which dries with perfect transparency, contains equal portions of ether and alcohol, and an amount of gun-cotton varied according to its quality — six grains usually being sufficient — is adopted, and to every ounce of this are added—

Nitrate of silver	$7\frac{1}{2}$	grs.
Chloride of strontium	2	,,
Citric acid	1	,,

A plate of opal glass, thickly flashed, of a pure creamy-white surface, well ground and polished, is coated with the collodio-chloride of silver, and when *quite* dry is placed cautiously in contact with a negative, and printed in the usual way, the time of exposure being somewhat less than is required for paper prints, but of course varying with the character of the negative and that of the light. It is better to over rather than under print, because the one may be reduced by a strong solution of cyanide of potassium, or used as a transparency, while the under-exposed print is useless for any purpose, and is past remedying. When taken from the printing-frame, the proof is toned in any one of the alkaline gold-toning solutions used in a weak and old condition, and fixed with hyposulphite of soda, 1 oz. in 10 of water. Mr. Simpson has been awarded the President's medal of the Photographic Society for this process.

New Camera Stand.—Mr. Springham introduced at a meeting of the North London Photographic Association an improved stand for the camera, of which the following is a description, given in the words of the inventor :—"This invention is applicable not only to cameras, but also to telescopes and other instruments requiring horizontal and vertical motion. It consists of the ordinary iron triangle, to two corners of which are fixed two pieces of iron curved towards each other, and each having a horizontal slot through it in which moves a little iron foot attached to the front part of the camera. The other angle of the triangle has a horizontal extension, in which is cut a vertical curved slit. In this works a curved screw having two flat sides, and which can be moved either vertically or horizontally in the slot, and secured in any position by means of two nuts running on it. This screw is attached to the hinder part of the camera. The curves of the three slots and the curved screw have all one common centre, which enables them to work together. Mr. Springham claims for this stand that it is lighter than any other possessing similar advantages, firmer, and while easily detached from the camera, holds it immovably at all other times.

New Air-tight Bath.—Mr. A. G. Clifton, a gentleman to whom photographers owe other ingenious improvements in photographic apparatus, calls attention, in a communication to our useful contemporary *The Art Student,* to a new air-tight bath which is a great improvement upon those usually made. The appended cut and description will suffice by way of explanation. *A* is the elevation of the ordinary bath, the weak points in which are at *c c,* which after a little wear, from the great pressure of the screw, *F,* are apt to give. *B* is the elevation of the improved bath, which instead of the framework, *c c c*, made with the additional top-piece *D*, has only *E*, and by merely slipping the two brass rods at *c c*, and screwing it down by the thumb-screws, *a*, it becomes air-tight, without weakening the sides, *c c*.



New Lens for Carte Portraits.—Mr. Davies, of Edinburgh, an amateur photographer and experimentalist of repute, for whose opinion we have extreme respect, speaks very highly of a new lens for *carte* portraiture recently introduced by M. Darlot, of Paris. It is of short focus and singularly wide aperture, and is said to be far more rapid in its action than any other lens of the kind made in this country. The stops are arranged very ingeniously by a novel system of levers, one taking the place of another with the greatest ease and readiness.

The Oxyhydrogen Light.—At the May meeting of the South London Photographic Society, Mr. Alfred Harman called attention to some improvements he had made in the retort in ordinary use for generating this light as used for photographic enlargements by the solar camera—a branch of the art in which he is attaining great repute. Using one of Jones's retorts made of cast-iron, with a top fitting like that of a collodion bottle, to prevent an explosion, he found a greater danger unprovided for in the rapidity with which the gas was generated (consequent upon the quantity of cast-iron contained in this retort), which is so great that very often the pipes are not large enough to convey it quickly enough to the bags, and the accident in question occurs, despite the top. The improved retort is shaped like a coffee-pot, and made of sheet iron, the pipes are larger, and at the top there is a safety-valve, which, if there should be a stoppage in the pipe, opens and allows the oxygen to escape. The smaller pipes in common use are frequently clogged by the manganese and chlorate mixture getting into them; to avoid this danger, the pipe leading from the retort to the washing-bottle, is twice the size of that usually employed, and is also provided about midway with a hollow ball intended to receive any water that would otherwise pass into the retort, in cases when it becomes necessary to lower the temperature, and so check the too rapid generation of the gas. A second washing-bottle is used, because on trial the water in it was always found to be more or less impregnated with the manganese, which in its absence would pass into the bag, but the larger pipe is not used after the first washing-bottle is passed.

PHYSICS.

Diffusion of Gases through India-Rubber and Biscuit-ware.—Mr. G. F. Ansdell records the results of some experiments which he has been recently making, in order to determine the presence of fire-damp in mines. He has found that gases diffuse through india-rubber somewhat slowly, although they diffuse rapidly through biscuit-ware. If a glass cylinder be intercepted at its middle by a plate of biscuit-ware firmly cemented in, and then one end of the cylinder be covered with a thin sheet of india-rubber, and diffusion allowed to proceed through this india-rubber, the gas (coal gas especially) which has diffused through it remains between that substance and the biscuit-ware, exerting considerable force, although the other end of the cylinder be perfectly open to the atmosphere. The cause of this phenomenon is somewhat obscure, but Mr. Ansdell is disposed to think that it will be found in the existence of two forms of the same gas (mine gas for example), one of which will permeate india-rubber but not biscuit-ware, and *vice versâ.*—See *Chemical News*, June 9th.

Spectroscopic Examination of the Nebulæ.—Mr. Huggins, who has been lecturing at the Royal Institution upon this subject, gives the following as the opinions warranted by his researches:—

(1.) The light from these nebulæ emanates from intensely heated matter in the form of gas. This conclusion is corroborated by the great feebleness which distinguishes the light from the nebulæ.

(2.) If these enormous masses of gas were luminous throughout, the light from the portions of gas beyond the surface visible to us, would be in a great measure extinguished by the absorption of the gas through which it would have to pass. These gaseous nebulæ would therefore present to us little more than a luminous surface.

(3.) It is probable that two of the constituents of these nebulæ are the elements hydrogen and nitrogen, unless the absence of the other lines of the spectrum of nitrogen indicates a form of matter more elementary than nitrogen. The third gaseous substance is at present unrecognized.

(4.) The uniformity and extreme simplicity of the spectra of all these nebulæ oppose the opinion that this gaseous matter represents "the nebulous fluid" suggested by Sir William Herschel, out of which stars are elaborated by a process of subsidence and condensation. In such a primordial fluid, al the elements entering into the composition of the stars should be found. If these existed in the nebulæ, the spectra of their light would be as crowded with bright lines as the stellar spectra are with dark ones.

(5.) A progressive formation of some character is suggested by the presence of more condensed portions, and in some nebulæ of a nucleus. Nebulæ which give a continuous spectrum, and yet show little indication of resolvability, such as the great nebula in Andromeda, are not necessarily clusters of stars. They may be gaseous nebulæ, which, by the loss of heat or the influence of other forces, have become crowded with portions of matter in a more condensed and opaque condition.

(6.) If the opinions of Lord Rosse and others, to the effect that these nebulæ are systems formed by the aggregation of gaseous masses be correct, how is it possible that their permanence of general form can be maintained?

(7.) The opinion of the enormous distance of the nebulæ from our system having been founded upon the supposed extent of remoteness at which stars of considerable brightness would cease to be separately visible in our telescopes, has no longer any foundation on which to rest, in reference at least to those nebulæ which give a spectrum of bright lines. It may be that some of these are not more distant from us than the brighter stars.

(8.) Mr. Huggins thinks that these nebulæ are gaseous systems, possessing a structure and a purpose in relation to the universe, altogether distinct from the great cosmical masses to which the sun and fixed stars belong. He asks what is this special purpose, but at the same time he expresses the opinion that science will be more advanced by the laborious accumulation of facts than by the easier feat of throwing off brilliant speculations.

The Mechanism of the Spectroscope.—In an article in a recent number of *Silliman's Journal*, Mr. L. M. Rutherford gives an account of the apparatus for spectroscopic inquiry, which he has employed. In his instrument the two principal telescopes are provided with objectives of 1·6 inch aperture and 19 inches focal length. The slit, or collecting telescope, has but one motion about a vertical axis at the side of the platform and just in front of the objective, enabling it to command all parts of the platform. The observing telescope has two motions—one about the central axis of the instrument, and the other about a second vertical axis, which, by means of a slide capable of being clamped, can be placed under the last surface of any prism on the platform; thus commanding by one motion the whole spectrum. Before the slit is a prism for the comparison of different spectra; and the observing telescope is provided with eye-pieces of various powers. The first circuit consists of six prisms, which are of glass, faced with plates of glass cemented with glue and molasses. These are each about the angle of 60°, and present an aperture of 2·9 × 1·8 inch. The faces to receive the glass are carefully ground to a flat surface, and the glass, quite thick and free from veins, has been selected with reference to the flatness and parallelism of the sides. Since, however, it is scarcely possible to find glass with parallel surfaces, care has been taken so to place the glass, that the inclination of its faces is perpendicular to the axis of the prism. Mr. Rutherford gives a deal of further information touching the construction of the elements of the spectroscope, which we are compelled to omit notice of through want of space. Those of our readers who are interested in the subject should consult the original article in *Silliman's Journal*, vol. xxxix., No. 16.

The Unit of Electrical Resistance.—The battle between Mr. Fleeming Jenkin and Dr. Matthiessen on the one side, and Dr. Siemens on the other, upon this question has resulted in the complete triumph of the two former. Mr. Jenkin, who lately read a most valuable paper upon the subject of electrical units of resistance, proved incontestably that the method proposed by Dr. Siemens is unreliable. Since then, Dr. Matthiessen has published an essay upon the "Specific Resistance of the Metals" (a subject which his numerous discoveries highly qualify him to undertake the investigation of), in which he advances many facts in support of the accuracy of what is termed the "B A Unit (1864) of Electrical Resistance," and shows some of the errors which have resulted from the employment of Dr. Siemens' process. Dr. Siemens' unit is known to electricians as the "mercury unit," and it is defined as the resistance of a column of mercury, a metre long, and a square millimetre section at 0°. In reference to it, Dr. Matthiessen asserts — 1st, That no true mercury unit has been issued; 2nd, That the units issued from time to time have not the same resistance. He proves his first assertion by showing that in making the calculations for the mercury unit, the wrong specific gravity of mercury was used, viz. 13·557 at 0°, instead of 13·595 as found by Regnault, Kopp, Balfour Stewart, and Neumann. In support of his second statement, Dr. Matthiessen alleges that there were two sets of coils in the Exhibition of 1862, said to be reproductions of the mercury unit. One was exhibited by Siemens of London, the other by Siemens of Berlin; and when the two sets were compared with each other, they showed a difference of about 1·2 per cent.—*Vide* Dr. Matthiessen's paper in *Philosophical Magazine*, May.

Pseudoscopic Vision through Prisms.—Some curious effects of prisms upon the apparent distance of objects viewed through them were pointed out by Mr. Dancer at a meeting of the Manchester Philosophical Society, which was held on April 4th. If we look with both eyes at an object, such as the flat top of a table for example, and then interpose a prism between one eye and the object, we discover, after a short time, that the portion of the surface to which the sight is particularly directed has apparently changed its distance. If, in trying the experiment, the edge of the prism is turned towards the nose, the flat surface will appear concave; if, on the contrary, the base or thick edge is turned towards the nose, the surface will appear convex. The full effect of this alteration in the appearance of the object is not realized immediately; some persons see it perfectly in a few seconds, others require some moments of steady gazing before it becomes evident to them. The character of the surface to which the vision is directed exercises some influence on the production of the effect. A circular table covered with a cloth of bright pattern, having a few articles disposed toward the edges, exhibits this fallacious vision in a marked degree. The angle of the prisms for performing these experiments should be about 15°; if less than this, the alteration or depression of surface is not sufficient to produce a good effect; if the angle is much greater than 15°, many persons are unable to unite the refracted image of the prism with the real image seen by the other eye. Achromatic prisms are to be preferred to those that have not been corrected for colour. Experiments with these prisms have shown that the power of converging the optic axes differs very considerally in individuals. Oculists occasionally recommend prismatic lenses, mounted in spectacles, to assist persons whose *recti interni* muscles are not sufficiently powerful; Mr. Dancer considers that it would be interesting to know if those so assisted have noticed the fallacious appearances which the healthy eye can appreciate. The pseudoscopic effects are exaggerated by using a prism for each eye, but in most persons this produces a painful sensation. He explains the phenomenon by supposing that in binocular vision we estimate the distance of an object by the degree of convergence of the optic axes.

A New Thermo-Element.—The following account of this piece of electrical apparatus has been given by the inventor, M. S. Marcus :—(1.) The electromotive force of one of the new elements is one twenty-fifth of that of a Bunsen's element, and its resistance is equal to 0·4 of a metre of normal wire. (2.) Six such elements can decompose acidulated water. (3.) A battery of 125 elements disengaged in a minute 25 cubic centimetres of detonating gas. The decomposition took place under favourable circumstances, for the internal resistance was far greater than that of the interposed voltameter. (4.) A platinum wire, half a millimetre in thickness, introduced into the circuit of the same wire, is melted. (5.) Thirty elements produce an electro. magnet of 150 pounds' lifting force. (6.) The current is produced by heating one of the junctions of the elements, and cooling the second by water of the ordinary temperature. The alloys employed by M. Marcus are different from those in general use, and have the following composition :—

The positive metal	Copper............	10	parts.
	Zinc................	6	
	Nickel............	6	
The negative metal.........	Antimony	12	parts.
	Zinc................	5	
	Bismuth	1	

The bars are not soldered together, but bound by means of screws. One of the most interesting facts in connection with this battery is the proof it affords of the actual conversion of heat into electricity, for the water which is used in cooling the second point of contact becomes only slowly warmed, while the circuit is closed but very rapidly when it is open.—Vide *The Philosophical Magazine*, vol. xxix., No. 197.

The Action of Sulphur in the Voltaic Pile.—M. Matteucci, in commenting upon the sulphur-battery lately invented by M. Blanc, observes, (1.) that finely-divided sulphur in contact with the electro-negative metal of a pile formed of zinc, copper, and solution of common salt, intensified the power of the combination ; (2.) Sulphur, though insoluble and an insulator, enters into combination with the sodium set free by the current.—Vide *Comptes Rendus*, April 3rd.

ZOOLOGY AND COMPARATIVE ANATOMY.

Anatomy of the Lower Echinoderms.—M. Jourdain has published a memoir upon the anatomy of the siponculus, one of the lowest and most annuloid of the Echinodermata. Notwithstanding all that has been done toward the investigation of the structure of the members of the star-fish class, there is still abundant room for inquiry, and M. Jourdain's researches, though they do not tell us a great deal, are nevertheless acceptable. The more interesting part of his memoir is that which relates to the general lacunar cavity of the body, and to the arrangement of the circulatory and respiratory systems. The general lacunar fluid contains a great quantity of corpuscles, whose clearly-defined characters appear to resemble those of the blood-corpuscles of vertebrates. These corpuscles have the form of colourless nucleated cells, circular in outline, and disk-like in form. The blood flows regularly in a definite direction ; it passes from behind forwards along the walls of the body, and then travels in the opposite direction in the neighbourhood of the intestine. The movement is in great part maintained by clusters of cilia situate on the surface of the intestine and the mesenteric folds. The circulatory apparatus in *S. obscurus* is composed of an undulated reddish tube, which lies below the first or simple portion of the digestive canal. In *S. gigas* this tube is double ; in fact, a second vessel may be seen below the first division of the alimentary canal. Posteriorly this single or double tube terminates in an inflated *cul-de-sac*. Anteriorly, it opens into the circular sinus which surrounds the pharynx, and which communicates freely with the tentacular crown. The walls of the circulatory tube are supplied with muscular fibre, and are consequently contractile ; but the contained blood is set in motion rather by ciliary action than by any operation of the vessels.—Vide *Comptes Rendus*, May 15th.

A New Gall-producing Insect, which is parasitic upon the common creeping rye-grass, was described by Mr. W. Couper, some time since, at a meeting of the Quebec Entomological Society. The species belongs to the Hymenoptera, or Bee order. As soon as the larva issues from the egg, it places its head downwards in the gall, remaining in that position till it eats its way through. About the end of September it ceases to feed, and prepares to meet a Canadian winter. By this time the gall is hardened, and the larvæ remain in a torpid state, becoming active again in the spring, and changing to perfect insects in time to attack the young grass of the season. The Baron Osten Sacken, to whom Mr. Couper's specimens were transmitted for identification, regards the insect as belonging to the genus *Eurytoma*, but is unable to say whether it is *E. fulvipes* or not.—Vide *The Canadian Naturalist and Geologist*, New Series, vol. i., No. 6.

The Mammalian Brain Controversy.—In a recently published number of the "Proceedings" of the Royal Society, we observe a report of Professor Owen's paper on the anatomy of certain portions of the marsupial brain, and Mr. W. H. Flower's reply thereto. The Professor, who gave his paper a somewhat vague title, made a very decided attack upon the Conservator of the Museum of the College of Surgeons. He accused this gentleman of mis-stating his (Professor Owen's) view, and of borrowing his ideas. To those to whom Mr. Flower is personally known, such charges appeared unfair ; but inasmuch as any assertion of so distinguished a man as Professor Owen carries a considerable weight with it, it became necessary for Mr. Flower to repudiate them. From a perusal of the two communications, we feel justified in stating that Professor Owen's charges are entirely unfounded. It seems to us, too, that Professor Owen left the readers of his former papers to imagine that among the Marsupialia and Monotremata the cerebral hemispheres are *not* united by a *corpus callosum.*

The Classification of the Annelida is a subject on which a valuable essay has appeared from the pen of M. de Quatrefages. The memoir is far too long to give even an abstract of it, but we may mention that the writer, whose taxological scheme occupies nine quarto pages, divides the entire class into two orders, four sub-orders, twenty-six families, and 181 genera. The two orders are characterized by peculiarities of the segments which compose the annelid's body: thus, in the *Errantes*, all the segments are alike, but in the *Sedentaires* the body may be regarded as being made up of a series of segments, or sets of segments of different kinds.

Composition of Oyster Liquor.—M. Payen's observations upon this point are worthy at least of the attention of oyster-eating *savants*. The liquid found in the substance of the oyster and among its tissues is not simply sea-water, for it contains less salt and more organic matter. When shaken with ether, it deposits some albuminous material containing 8·75 per cent. of nitrogen. The liquor probably plays some part in the nourishment of the oyster, the weight of which is nearly always equal to that of the liquid. The following is the composition of the latter:—

Water	95·888
Salts	3·022
Nitrogenized matter	0·560
Non-nitrogenized ditto	0·529

Subjoined are the relative weights of shells, animal substance, and liquor, in a dozen oysters weighing 1,482 grammes:—

Shells	1209
Flesh	112
Liquor	102

By converting the nitrogen of the oyster into nutritive matter, M. Payen calculates that a dozen oysters represent in nitrogenized matter only the tenth of a man's ration.—Vide *The Chemical News*, April 28th.

M. de Quatrefages and M. Claparède.—While the ink with which we have written the above account is drying, we have received from M. Quatrefages a copy of his memoir on the classification of Annelids, with an appendix explaining away some of the objections which the *savant* of Geneva has raised to his views. We give a translation of M. de Quatrefages' remarks. "The appeal which I made to my fellow-workers in publishing in the *Comptes Rendus* the paper of which the present is a reprint, has elicited some written observations from M. Claparède, which he has been good enough to forward to me with his *Glanures Zootomiques*, and an article published in the *Bibliothèque Universelle de Genève* for April, 1865. I received these important documents at the moment I was correcting the proofs of my memoir. Pressed by time and inexorable business, I was unable to give them that study and serious consideration which they deserved; the 'Glanures' especially, for it contains a great number of new facts which ought to have been taken into account, and which I shall certainly deal with as it deserves in my future work. The article in the *Bibliothèque* is a critical essay. The writer has appreciated my views and their application, and has added comments upon certain facts." These strictures M. de Quatrefages then proceeds to reply to in fifteen paragraphs, which are far too long for analysis here. We may however remark that those interested in the classification of Annelids will find that M. Quatrefages has the best of the discussion, both in fact and in courtesy.

The Chair of Zoology at the Museum of Natural History in Paris, which is vacant through the death of M. Valenciennes, the veteran ichthyologist, will, it seems likely, be given to M. Lacaze Duthiers, so well known for his researches upon *Coral* and *Bivalves*, his most formidable opponent being M. Louis Rousseau, the assistant naturalist in the Museum.

The Return of Election of Fellows of the Royal Society includes the names of two most deserving naturalists, whose labours all zoologists will be glad to see thus rewarded—Mr. G. R. Gray, known for his contributions to systematic zoology, and Mr. W. R. Parker, of whom it is only just to say that he is one of the ablest comparative osteologists in Europe.

A European Axolotl.—M. Duméril has written to the Academy announcing the reproduction of a number of young Mexican axolotls (Siredon Mexicanus) in the reptile menagerie of the Natural History Museum. In the memoir, or rather note, which the great herpetologist has sent to the *Comptes Rendus*, the development of the ova is minutely detailed, and the evidence fully corroborates the long-existing opinion that the axolotl is a true batrachian reptile.

The Circulation of the Blood in Spiders of the genus Lycosa has been carefully investigated by M. Edouard Claparède, who has conducted his inquiries chiefly upon the above-named genus, from the circumstance of the transparency of the individuals it embraces. The heart or dorsal vessel is situate in the median line, semicircular in profile, and reniform in transverse section. At different parts it presents lateral diverticula, arranged in pairs, of which there are three, the posterior one being the least developed. At the level of each pair of diverticula there is a pair of those orifices like button-holes first discovered by Strauss in insects, and since detected in most of the *Arthropoda.* They are called by M. Claparède "venous orifices." At the moment of dilatation the blood rushes into the heart by these orifices. There are no valves to these orifices in the young Lycosæ, their movement depending merely on the general muscular fibre of the heart. The blood escapes from the heart by the thoracic aorta, and by a tubular posterior or caudal aorta; whence it communicates with a wide reservoir situate at the base of the spinnarets. The heart itself is placed in a space which is termed the pericardial space, whence all the blood entering the heart is derived. M. Claparède considers that the circulation in Lycosæ is *par excellence* "lacunar," and regards the "vascular networks" of M. Blanchard as having no real existence. —Vide *The Quarterly Journal of Microscopical Science*, No. XVIII.

The Nervous System of the Earthworm, according to the elaborately conducted inquiries of Mr. E. Ray Lankester, consists of a supra- and a sub-intestinal portion, both of which possess the usual component fibres and cells. The principal centre is the cephalic bilobed ganglion, *homologous with the corpus callosum and the commissure prolonged through the corpora quadrigemina* (!) From this in one direction pass the cephalic nerves, in the other the pharyngeal crura, uniting beneath the pharynx to form the sub-ventral cord and ganglia. From the pharyngeal ring four branches on either side unite to form the supra-intestinal chain or plexus discovered by Mr. Lockhart Clarke, and homologous with the sympathetic and visceral ganglia of mollusca. Four other twigs on either side are distributed to the pharynx. The muscles of the segments are presided over by the sub-ventral cord. There are no organs of special sense, unless the labial segment should be so considered.

The Arrangement of the Invertebrate Collection in the British Museum.—A letter has been addressed to Government on this subject by a person who signs himself "Philocosmos." From a perusal of his statements we commend his letter to the notice of our readers. His recommendations are these :—

(1.) Let us have the whole material of the collection arranged with some attempt at systematic order.

(2.) Let the "Civil Service" rules as to vacant appointments in this part of the Museum be entirely abandoned.

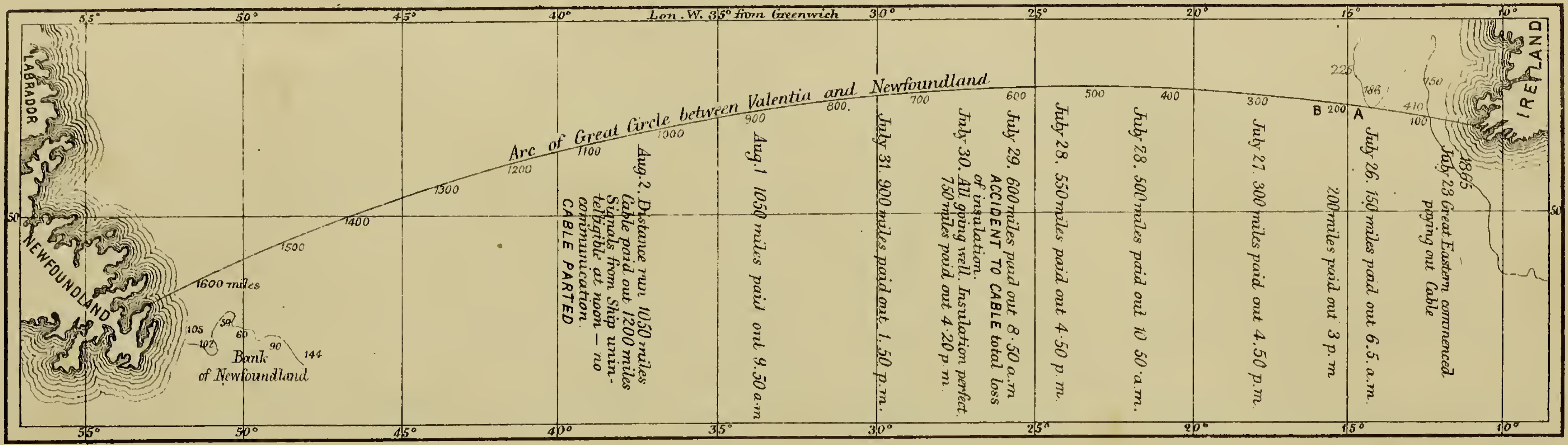
(3.) The permanent class of assistant keepers of the sub-class (!) insecta of the invertebrata should be very materially increased. Mr. Gregory's remarks, *àpropos* of this matter, are, unhappily, too true. In a debate which took place upon the subject of the Museum in the House of Commons on May 5th, this gentleman said :—"If you went into the insect-room you would be glad to get out of it, so dark, dingy, and stuffy was it ; and if you asked to see a specimen, ten to one but you would be told that it was shut up in a box for want of space to exhibit it."—*Vide* pamphlet, Hardwicke, 1865.

Classification of the Lemurs.—Mr. St. George Mivart, of St. Mary's Hospital, has just issued a reprint of his important memoir upon the above subject. His essay, which extends over forty closely-printed pages, details with minuteness the various anatomical and morphological characters which it is essential for the zoologist to grasp in forming a true conception of the relations and affinities of these interesting quadrumana. We have already (Popular Science Review, No. 14) given the arguments which Mr. Mivart advances for the separation of Lemuroidea from Anthropoidea. We now confine ourselves to his arrangement of the former. These he considers to be naturally divisible into the three families, *Lemuridæ*, *Tarsidæ*, and *Cheiromyidæ*—Galeopithecus, as he believes, forming no part of the order Primates. To the already well-known distinctions of these three groups, he adds, that in the *Tarsidæ* the third digit of the hand is the longest, while the second and fourth digits are nearly equal, a combination which, according to Mr. Mivart, occurs in no other species of the sub-order. Again, in Tarsius alone, of all the *Lemuroidea*, is the orbit closed behind by a union of the malar with the alisphenoid bone. This reappearance of a marked and exceptional character among mammals (one otherwise quite peculiar to the Anthropoidea) is most interesting ; as, if *Tarsius* is thus demonstrated to have a near connection with the higher Primates, then, *à fortiori*, the higher Lemuroidea must have such also ; and thus we have a strong argument against the complete separation, as a distinct order, of the last-named group, and a reason for these merely *sub*-ordinal distinctions. The following is an outline of Mr. Mivart's scheme of classification :—

SUB-ORDER.	FAMILY.	SUB-FAMILY.	
Lemuroidea...	1. Lemuridæ ...	Indrisinæ Lemurinæ Nycticebinæ Galagininæ	Here follow the genera, for which however we have not space.
	2. Tarsidæ		
	3. Cheiromyidæ		

BRITISH MUSEUM NATURAL HISTORY.

FIG. I. MAP SHEWING COURSE OF ATLANTIC CABLE FROM VALENTIA TO TRINITY BAY 1865.



1865 July 23 Great Eastern commenced paying out Cable

July 26. 150 miles paid out 6.5. a.m.

200 miles paid out 3 p.m.

July 27. 300 miles paid out 4.50 p.m.

July 28. 500 miles paid out 10 50 a.m.

July 28. 550 miles paid out 4·50 p.m.

July 29. 600 miles paid out 8·50 a.m ACCIDENT TO CABLE total loss of insulation.

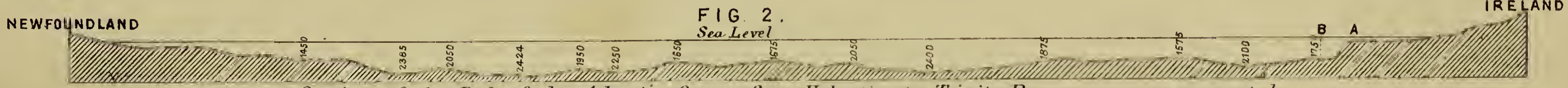
July 30. All going well. Insulation perfect. 750 miles paid out 4·20 p.m.

July 31. 900 miles paid out 1. 50 p.m.

Aug. 1 1050 miles paid out 9.50 a.m

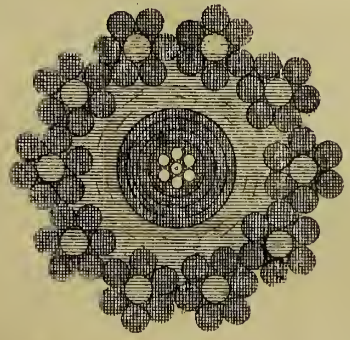
Aug. 2. Distance run 1050 miles Cable paid out 1200 miles Signals from Ship unintelligible at noon — no communication. CABLE PARTED

FIG. 2.



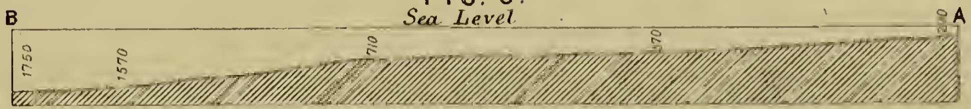
Section of the Bed of the Atlantic Ocean from Valentia to Trinity Bay, on an exaggerated Scale of 15 vertical to 1 horizontal.

FIG. 4.



Section of the Atlantic Cable 1865.

FIG. 3.

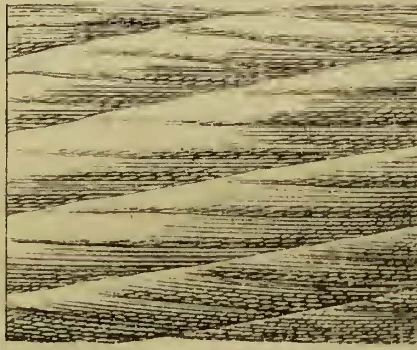


Section of Edge of the Irish Bank. From A to B on Plan
Drawn to natural Scale.

The Soundings in fathoms._ By Lieut. J. Dayman R.N. H.M.S. Cyclops.

Length of Cable shipped 2300 miles
Weight per mile 35 cwt. 3 qrs
Breaking Strain 7 3/4 Tons
The greatest Depth encountered 2 1/2 miles.

FIG. 5.



Side View of the Atlantic Cable

Jas. B. Jordan del.

W West lith.

ATLANTIC TELEGRAPHY.

BY ROBERT HUNT, F.R.S.

FOR the third time man has failed in his attempt to make a channel along the deep sea-bed of the Atlantic Ocean, through which to send those electrical pulsations, by whose regulated throbs he desires to unite the great Continents of the world. These failures have been of no common order, immense sums of money have been expended, and a considerable amount of scientific knowledge has been brought to bear upon the Atlantic Telegraph. Are we to be discouraged at this recurrence of accidents? Or shall we learn good practical lessons from our failures, and thus secure a more favourable result when the next experiment is tried? It is now eight years since the proposal was made to connect Europe and America by means of a submarine electric telegraph cable. About seven years have passed away since the first electric cable broke, 380 miles from the Irish coast. This occasioned a delay which was in every way disastrous. The cable was stored—with very insufficient care—in the Government yard at Keyham, where it remained for the winter, and in the latter summer of 1858, by the aid of the *Agamemnon* and the *Niagara*, the experiment of sinking it was again made. On the 5th of August, in that year, the cable was laid across from Ireland to Newfoundland, and we are informed, upon good authority, that between that date and the 1st of September 300 messages passed between Europe and America. It must not be forgotten, that those messages were obtained with difficulty, and it is quite certain that, from the very first, the cable was not in working condition. While the cable was being coiled on board the *Niagara*, I had an opportunity of examining it, which I did with some care. The result was a firm conviction, then expressed, that the cable had been greatly injured, and that, if sunk, it would very soon become useless. On the 1st of September, 1858, the electric band ceased to convey a sign, and until the present year nothing further has been effected. The failures of the Red Sea line, and some other deep-sea telegraphic cables, have rendered the commercial character of this description of enterprise very problematical; and hence, the hesitation of the public to subscribe the required capital, and the long delay in making a new experiment.

Presuming that the readers of this journal will be sufficiently acquainted with the principles upon which telegraphic communication, by means of electric currents, depends, it will be sufficient to state the peculiarities of the arrangements which have proved successful, and then proceed to the examination of the greater question of the Atlantic line.

The Dover and Ostend cable was laid on the 6th of May, 1853. This cable (fig. 6, Pl. XXI.) is 70 miles long; it is composed of six copper wires, insulated by a coating of gutta percha, which are essentially the electrical cable, and these are secured by an armour of twelve iron wires. The whole rope was capable of sustaining a strain of about 50 tons; it weighed seven tons per mile, making a total weight of nearly 500 tons. It was made by Newall & Co., in one hundred days, its cost being £33,000. It required seventy hours to coil it into the ship, and it was submerged in the sea, from Dover to Ostend, in eighteen hours. The arrangement of the inner wires did not prove entirely satisfactory.

After the success in sinking the Dover and Ostend cable, Messrs. Newall & Co. commenced laying a cable from Donaghadee, in Ireland, to Port Patrick, in Scotland, across the Irish Channel. This cable was of the same weight and size as fig. 6, but the conducting wires were differently arranged, as seen in fig. 7, Pl. XXI. The drawings given are of the natural size. This cable was made in twenty-four days, and at a cost of £13,000. The Mediterranean cable is of the same construction as that across the Irish Channel, and was laid in 1854. This line runs from Spezzia to the Island of Corsica. Over this there is a land line extending to the Straits of Bonifacio, where a short submarine line of seven miles runs to the Island of Sardinia. Across this island there is a line 203 miles long, terminating at Cape Spartivento. The telegraphic communication between the Island of Sardinia and Africa seems to have been surrounded with great difficulties. Two attempts were unsuccessful, but the third (fig. 11, Pl. XXI.) proved, by its success, that perseverance accompanied by judgment usually attains the end desired. This cable, also made by Messrs. Newall, was composed of four sets of conducting wires, and these, in the deep-sea portion, were protected by eighteen iron wires, while the shore end was surrounded by twelve much stouter wires. The shore cable was six miles in length. The distance between Cape Spartivento, in Sardinia, and Bona, on the African coast, is 125 miles. Messrs. Newall & Co. also made the cable which unites Malta and Corfu with

SECTIONS OF SUBMARINE TELEGRAPH CABLES.

Full Size.

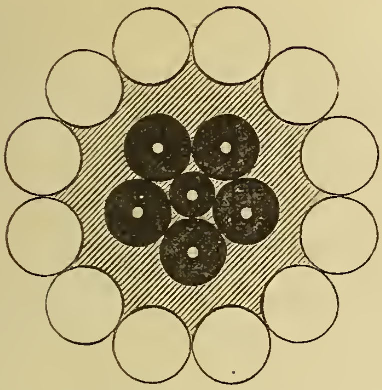


Fig. 6.
CABLE FROM DOVER TO OSTEND
(1853. *Length*, 70 *miles*),
AND ZUYDER ZEE, 5 *miles*.

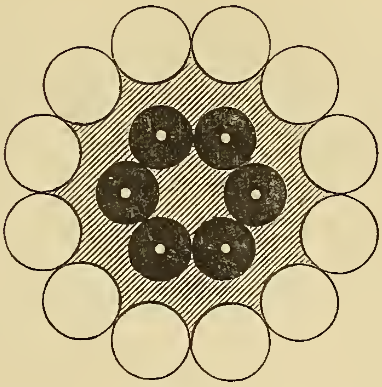


Fig. 7.
FROM PT. PATRICK TO DONAGHADEE
(1853. *Length*, 25 *miles*),
AND SPEZZIA TO CORSICA, 110 *miles*.

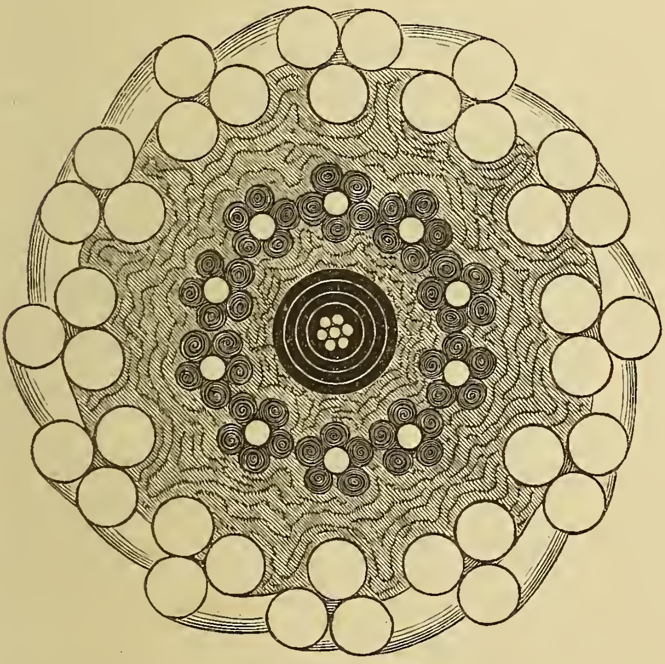


Fig. 8.
THE ATLANTIC CABLE—SHORE ENDS,
1865.

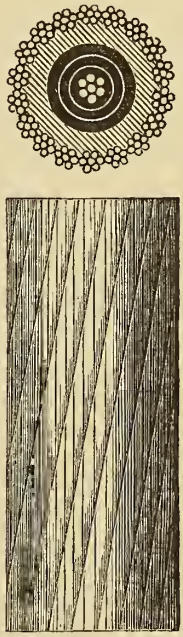
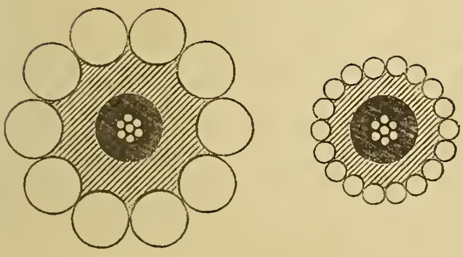
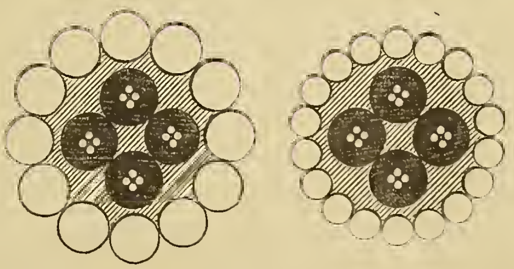


Fig. 9.
THE ATLANTIC CABLE,
1858. *Length*, 1670 *miles*.



Shore Ends. *Deep Sea.*

Fig. 10.
CORFU TO MALTA. (*Length*, 400 *miles*),
AND MALTA TO SARDINIA, 370 *miles*.
1857.



Shore Ends. *Deep Sea.*

Fig. 11.
SARDINIA TO BONA, AFRICA.
Length, 125 *miles*.
1857.

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Sardinia. As shown in the sections (fig. 10, Pl. XXI.), the electrical cord is composed of seven small wires twisted together and insulated by a thick layer of gutta percha. The deep-sea portion is protected by eighteen small iron wires; while the shore end is covered by an armour of ten stout iron wires, and which is consequently much heavier than the deep-sea cable. The weight of the deep-sea section of this cable is 1,960 lbs. per mile, and its total cost was £125,000. These may be regarded as typical examples of nearly all the submarine electrical cables which have been laid. It becomes necessary to give a little more in detail the description of the Atlantic cable of 1858 (fig. 9, Pl. XXI.). The electrical conductor was a copper strand, consisting of seven wires—six laid round one, forming in fact, as far as electricity is concerned, only one wire. This weighed 107 lbs. per nautical mile of 2,028 yards. It was carefully insulated with gutta percha, laid on in three coatings, and weighing 261 lbs. per nautical mile. Eighteen strands of charcoal iron-wire—each strand composed of seven wires, six laid round one—laid spirally round the core. This was, however, previously padded with a serving of hemp, saturated with a mixture of Stockholm tar. The weight of this cable in air was 20 cwt. per nautical mile, while in water it was only 13·4 cwt. This made it equal to 4·85 times its weight in water; or capable of bearing its own weight in a little less than five miles deep of that fluid. Its breaking strain was estimated to be 3 tons 5 cwt.

The unfortunate failure of this enterprise—in which both Europe and America were equally interested—led to considerable discussion, and to a careful examination of all the conditions which were supposed to influence such electric cords. All the laws regulating the flow of an electrical wave were re-examined by some of our best electricians, and many previous conclusions received some correction. It had been supposed that an insulated submarine wire conducts according to a different law to that of a suspended circuit. This difference was thought to depend upon a system of induced earth currents influencing the submerged wire, which would not influence a wire when suspended in the air. A simple example to render this clear to the non-scientific reader may be necessary. If a wire insulated by means of gutta-percha, or any other non-conducting substance, is connected, so as to complete the circuit, with the two ends of a voltaic battery, a current is said to flow through it. This means that an electrical wave of motion is propagated along it in a given direction. If another copper-wire is placed near it—though not in contact with either it or the battery—another current, or wave, is generated, that is, *induced*, in it. This induced current interferes, to a greater or a less extent, with the primary current; and where great lengths of cable are concerned it becomes an element of serious consideration. If a coated wire is placed on the earth, and an electrical current is established in it, the earth acts the part of the second wire and induction is developed on its surface. Mr. S. A. Varley has examined this problem with much care, and has arrived at the following conclusions. In a suspended wire the insulatory medium of the air takes the place of the gutta-percha of the submarine circuit. The earth, which is the nearest conductor, is a considerable distance off, and is only on one side of the wire; therefore but little induction can take place between the wire and the earth. Nevertheless, induction to a certain extent does take place, and it can be detected with delicate apparatus in circuits of very moderate lengths. If the distance between the wire and the earth is decreased, induction will be developed more strongly, and the wire could be brought down, step by step, until the condition of a submarine circuit would be approached, where the earth surrounds the wire on all sides, and is only separated from it by the thickness of one-eighth or three-sixteenths of an inch of gutta-percha, a substance possessing, moreover, specifically a much greater inductive capacity than air. It, therefore, appears that the conditions are precisely the same, only differing in degree. It is, nevertheless, evident from this, that a submarine wire is placed under circumstances of greater difficulty than those which surround an aërial wire. This difficulty increases with the length of the wire, retardation becoming more and more powerful as the distance through which the wave has to move is extended. A submarine cable may be regarded as a Leyden jar; and the telegraphic indications are analogous to the discharges of a coated glass. An impulse is given by making a connection with a voltaic battery at one end of a wire suspended in air — and it indicates telegraphically by producing magnetic disturbance at the other—and a succession of impulses will rapidly give a succession of indications. Now, in an insulated submarine wire this is not exactly what takes place. A distinction has to be drawn between the simple arrival of a current—which may be regarded as instantaneous—and the production of a telegraphic signal. After having charged the wires sufficiently to develop an appreciable current—owing to the wire taking some time to empty itself—if currents are sent in succession with any rapidity, they will blend into one another, and, instead of getting a series of distinct impulses at the further extremity, a continuous undulating wave will be obtained. This sluggishness has been obviated, to a great extent, in circuits of moderate length, by employing opposite currents of electricity in succession. The effect of this is to absorb the preceding wave, and to neutralize it much more quickly than would be the case if the wire were left to discharge itself in the usual way. In a suspended wire, as there is but little induction, there can be no accumulation of static charge worth noticing; whereas a submarine wire, unless attention be paid to this, becomes useless for telegraphy. These remarks will serve to explain the reason why the telegraphic signals through the long line of the Atlantic telegraph will be so slowly delivered. The conditions are now well understood, and no doubt increased rapidity will be given to the rate of charging and discharging this vast length of wire, when it is laid again in the depths of the sea. The delicacy which has already been given to the instruments employed will be appreciated. The Atlantic Telegraph Company possess instruments which are capable of being rendered active, by the feeble current set up by the saliva of the mouth, acting on a sixpence and a piece of zinc, through a circuit of 500 miles, and record by a definite amount of attraction. It is difficult to conceive any instrument intended for practical use having a higher degree of delicacy than this. It is scarcely necessary to repeat, yet, desiring to make the conditions of an Atlantic cable perfectly intelligible to all, it is thought advisable to do so. The earth is a reservoir of electricity, and the wire which is laid over the deep-sea bed is also charged with this mysterious agent. When the earth and the wire are in the same state, there would be no indication in any instrument with which they may be connected. The balance remains undisturbed, the magnetic needle is at rest; but, produce the slightest motion in one, which is not produced in the other, and the needle gives a signal. This is the principle governing the electric band, and of course every arrangement is made so as to ensure the utmost degree of sensitiveness.

The electric conductor of the Atlantic cable is formed of seven wires (figs. 4 and 8, Pl. XXI.), six around one. Seven wires are used rather than one (see Plate) to give greater freedom to the electricity[1] in passing by presenting a more extensive surface to it. There are mechanical reasons also why a band of wires is preferable to one wire. The most serious accident that can happen to a submerged wire is its severance. Copper wier cannot always be depended upon to present the same amount of strength in every part. It frequently happens that an inch, or even a less portion of a wire, is crystalline, and therefore liable to break in being coiled. By using seven sections instead of one, the probability of a fatal breach of continuity is greatly reduced. It is scarcely to be expected that seven weak places would occur at the same spot, and, if a single wire were broken, it would not interfere, to any sensible degree, with the passage of the current. In constructing the Atlantic cable, however, the utmost care prevailed in every department. Every portion of the copper wire was submitted to exact examination, and no wire was used which possessed a lower conducting power than 85 per cent. of that of pure copper. The insulation of this conductor was thus effected. The centre wire of the copper strand was first covered with "Chatterton's compound" (that is, gutta-percha rendered viscid with Stockholm tar). This first coating was so thick that, when the other six wires forming the strand were laid spirally around it, every interstice became filled and air excluded. The mechanical solidity of the core thus formed was very great. This cable is nearly three times as heavy as the old Atlantic conductor, its weight being 300 lbs. to the nautical mile against 107 lbs. The complete exclusion of air, which is a most important object, is believed to be effected by this arrangement. The conductors of some cables have suffered from their being to some extent loose within their insulating covering. The core being thus formed next received another coating of Chatterton's compound, which quickly solidifies, and thus thoroughly protects, the whole. It was then surrounded with a coating of the purest gutta-percha, which was pressed around it in a plastic state, by means of a very accurate die, and sheathed the core in a continuous tube. Over this was again laid another coating of Chatterton's compound, for the purpose of effectually closing up any pores or flaws which may have escaped detection in the gutta-percha tube. To this covering succeeds a second tube of gutta-percha, then another coating of Chatterton's compound, and so on alternately, until the wire was covered with four coatings of gutta-percha, and four of the compound. This being completed, it weighs 400 lbs. to the nautical mile. It is well known that the insulating power of gutta-percha sensibly decreases by heat. The whole of the conductor was immersed in water of a temperature of 75° Fahr., in which it remained for twenty-four hours, and during the time it was constantly submitted to electrical tests. The core, after having been subjected to this and other tests, to prove the perfect character of its insulation, was then submitted to the process of being protected by its iron-wire armour.

Jute, which had been submitted to the action of catechu, in order to preserve it from decay, was very carefully wrapped around the core, and as fast as the wrapping proceeded it was coiled in water. If the water at any time penetrated to the wire, it would at once conduct away the electric current to the earth, and the loss of insulation would be at once detected.

This wrapping of jute is surrounded by ten wires manufactured from homogeneous iron. Each separate wire being itself, in the first instance, covered with tarred Manilla yarn, by which the iron was protected and the specific gravity of the mass lessened. By a very ingenious arrangement, which our space will not allow us to describe, the ten wires covered with the arred manilla hemp are spirally wound around the core, and the deep-sea cable is completed. The section and side view of the electric cable will be fully understood by reference to figs. 4 and 5. As the shore end of any cable is more exposed to the action of the waves than those parts are which remain in a state of rest at the bottom of the deep sea, it becomes necessary to give this portion a greatly increased degree of protection. Fig. 8, Pl. XXI., which is of the exact size of the shore end of the Atlantic cable, will fully illustrate the conditions of this portion. This "shore end" is the largest ever yet constructed. The core was formed by the main cable, which was wrapped with a serving of yarn to a size sufficient to receive around it twelve strands of iron wire, each strand being composed of three galvanized iron wires, each of which being nearly a quarter of an inch in diameter. The weight of the completed shore end was nearly twenty tons to the mile. Its diameter is 2½ inches, but at its junction with the main cable it is made to taper down to the size of the latter by a gradual diminution in diameter extending over 500 yards. This shore end was laid out for about twenty-eight miles from the coast of Valentia Island, when it reached water of the depth of 100 fathoms. From Hope's Content, Newfoundland, about eight miles of shore cable only would have been required.

The weight of the deep-sea cable—according to the Company's statement—in air was 35 cwt. 3 qrs. per nautical mile of 2,028 yards. Its weight in water, 14 cwt. to each nautical mile, or equal to eleven times its weight in water per knot; that is to say, it will bear its own weight in eleven miles deep of water. Its breaking strain was 7 tons 15 cwt. The length of cable shipped was 2,300 nautical miles; the actual distance from the point of departure, Valencia, on the west of Ireland, to the point Heart's Content, in Trinity Bay, Newfoundland, on which it was to have been landed, being 1,670 nautical miles. The sections which are given (figs. 1, 2, 3, Pl. XX.) show that the greatest depth to be encountered was 2,400 fathoms (14,400 feet), a little less than 2½ nautical miles. Mr. Saward, the Secretary of the Atlantic Telegraph Company, has stated the case so well that his words are borrowed.

"The problem in the case of the Atlantic Telegraph enterprise may be thus stated. Given a submarine telegraph core like that already described, constructed on the best known principles, and perfect as to its electrical conductivity and insulation, it is required to lower the same through the sea to a maximum depth of two miles and a half, so as not merely not to allow the insulating medium to be torn or stranded, but so as not to bring its normal elasticity to play against the more tensile but perfectly inelastic material of the conductor. For if the core were lowered into very deep water, like that referred to, without further protection, even supposing it to escape actual fracture by the adoption of extraordinary precaution, and by the aid of fine weather, it is evident that whenever, as would be highly probable, either in the act of paying out, during the lifting, or manœuvering of the ship, or even from the effects of its own weight, the gutta-percha sheath became extended to the limit of its elasticity, the copper in the centre would be stretched to a corresponding extent, and the tension being removed, the gutta-percha in returning to its original length would pull back the now elongated copper, which, thenceforward, would in every such case 'buckle up' and exert a constant lateral thrust against the gutta-percha; ending, probably, in its ultimate escape to the outside, and the consequent destruction of the core as an electrical agent. Moreover, in the event of an electrical fault being discovered in any submerged portion of the cable during the process of 'paying out' in deep water, it is of paramount importance towards its recovery and repair that the engineer should have such an assurance in the quality and strength of his materials as will enable him confidently to exert a known force in hauling back the injured part, without apprehension of danger to the vital portion of the cable."

Such were the difficulties which had to be provided for, and, in nearly every department, the utmost care was observable. Men of the highest class were selected, and the *Great Eastern* started on her enterprise with every prospect of successfully accomplishing the task of uniting Europe and America. The result is too familiar to all to require any notice of it in this journal. The "Diary" of Dr. Russell has made every one familiar with the progress of the experiment from the time the great ship commenced paying out the deep-sea cable, from the 23rd of July to the 2nd and 3rd of August, when we find, on the 2nd, at 8 P.M., a record of—"Signals from the ship unintelligible at noon. No communication with, or information received from, ship since. Cause unknown." And again, on the 3rd, 11.30 A.M.—"No information received from the ship. Cause unknown. No communication with ship." All was over. The electric nerve had ceased to throb. It lay dead, more than 1200 miles in length, at the bottom of the Atlantic. Desiring to record the progress of Atlantic Telegraphy, descriptions have been given showing the difference between telegraphic cables which have been laid successfully, and this one which has so signally failed. We read in a "Narrative," by Mr. John C. Deane, "We all clustered around Mr. Canning to examine the cable, and the conclusion, I may say, then unanimously arrived at was, that the injury was the deed of an assassin's hand—some demon in human form, who had deliberately driven into the external hemp a piece of wire used in the manufacture of the cable, having made an incision right through the gutta percha. One end of the piece of iron was sharp, as if it had been cut with nippers, the end coming out at the other side was broken off abruptly. One may easily imagine the indignation which this dreadful act created. Mr. Canning conferred with his assistants as to what was the best course to be taken. It was ultimately decided that the cablemen should be asked to examine the injury, and to give their opinion to the chief engineer. A meeting was held, and they arrived at the unanimous conclusion—'that it was done by wicked design.'" This was on the 31st of July, and on the 2nd of August—"There is a piece of wire!" was again proclaimed, and the enterprise was virtually at an end. Let us hope that accident, and not design, has led to this failure. It would be saddening to suppose that any man could be sufficiently degraded to sacrifice in this way the vast interests involved, and thus delay the accomplishment of so great an object. Of the condition of the Atlantic sea bottom nothing has yet been said. The map (fig. 1, Pl. XX.) shows, on a small scale, the direction in which the cable was laid, and the section (fig. 2) shows the bed of the Atlantic from Valencia to Newfoundland. No line could possibly be more favourable than this for a telegraphic cable, when once it was securely placed upon its bed. In the still and dark depths, without motion, it would have rested amidst ooze and mud. The only difficulty which was expected was on the edge of the Irish bank. This had been stated to present a sheer precipice of nearly 300 fathoms. A careful survey, by R. Hoskyn, master commanding Her Majesty's ship *Porcupine*, has, however, proved this to be a gradual incline, presenting no real difficulty (fig. 3).

The difficulties in the way of recovering the cable from the depths in which it lies buried are exceedingly great. Professor Airy said, "The whole question of submerging a cable was a problem of a most abstruse nature, far exceeding the complication of the motions of a planetary body through the heavens." It may with equal, if not more, truth be said, that the problem of lifting a cable through more than two miles of water—thus compelling it to describe two constantly varying curves, with all the resistance due to the drag of the ooze and mud of the sea bottom—is yet more complicated, and will demand the powers of the highest mathematical mind, united to mechanical ingenuity of no common order.

Waiting with much interest for the result of the next experiment, which is promised in the early summer of 1866, we cannot but think—seeing the amount of capital which is at stake, and that a single accident risks the whole venture—that some mode of catching the cable in case of fracture is deserving the attention of all concerned.

The task of placing an electrical cable between the British Islands and America has been proved to be possible. The difficulties of submerging such a cable are great, indeed. Yet it will as certainly be accomplished as the suspending of wires in the air between Liverpool and London has been accomplished; and, within a short period, electricity will be buying and selling, and telling all the tales of human passions, at a rate of not less than eight words in each minute, through the nearly two thousand miles of ocean waters which separate the great Continents of the world.

ON PURE WATER.

BY EDWIN LANKESTER, M.D., F.R.S.

PURE water is as necessary for health as good food or fresh air. Yet it is probably more neglected or less understood in modern times than either. I say modern times, because there is reason to believe that amongst the nations of antiquity, the Romans, at least, took more pains to obtain pure water than we do. It may be that our habit of taking water with something to flavour it, in the form of tea, coffee, sugar, salt, alcohol, or other agent, has rendered us less alive to the necessity of pure water than were people who had less means of indulging a taste for flavours than we have. Whether this be the case or not, terrible have been the inflictions on society from the neglect of a supply of pure water.

One example by way of introduction. In the year 1854 the cholera ravaged the metropolis. Up to August 31st of that year not more than twenty cases had occurred in the parish of St. James, Westminster. On that night upwards of 100 cases of cholera occurred in the neighbourhood of Broad Street, Golden Square, and more than half died. The next day the disease increased, and for four days it went on. Never was such mourning and desolation known in London since the days of the great plague. Upwards of 600 persons were killed in those five days. What could be the cause of this terrible outbreak? At first all was confusion. In the midst of the plague the late Dr. Snow accused the pump in Broad Street. It was shut up and the plague ceased. After this event the vestry appointed a committee to investigate the subject. On that committee were Dr. Snow, Dr. King, Mr. Marshall, the Rev. Mr. Whitehead, myself, and others. We investigated the whole attack from house to house. At last the fact became only too evident that wherever the water had been drunk from the pump in Broad Street between the 31st of August and the 4th of September there cholera had been the result. The pump was afterwards examined, and it was found that the well communicated with a cesspool in an adjoining house. No evidence can be more convincing than that brought forward by this committee, that the impure water of this pump was the active cause of the outbreak of cholera. I bring forward this case now as it may be a timely warning, and also as an illustration of the importance of securing, at least for drinking purposes, pure water.

As an organic being, man requires water for the performance of the functions of his life. Water is necessary to the existence of the universal world. Rocks and the inorganic substances of the earth assume their forms in obedience to the influence of water. The great physical features of the earth's surface have been determined by the action of water. As it assumes the solid, liquid, and gaseous forms under the influence of heat, it is one of the great agents of change upon the surface of the earth. Plants and animals may be regarded as organised water. There is no life upon the globe without water. Many of the lower forms of animal and vegetable life consist mainly of water. A jelly fish, weighing many pounds, was found to contain only a few grains of other constituents. All organic matters when dead lose a great portion of their weight when exposed to heat, on account of the evaporation of the water which they contain.

The life of plants and animals is maintained by the chemical changes which go on in their tissues by the agency of the organic elements, carbon, hydrogen, oxygen, and nitrogen. But these elements are not conveyed into the plant or animal in their pure form. The plant takes them up in the form of carbonic acid and ammonia. Neither are these compounds taken up in their pure form. They are conveyed into the tissues of plants by the agency of water. Each drop of rain, as it descends for the nourishment of the vegetable kingdom, contains its quota of carbonic acid and ammonia, and it is the water which is absorbed, and which carries into the system of the plant these compounds. Not only are the organic elements thus carried, but the mineral constituents of plants, the salts of lime, soda, and potash, are thus conveyed. Arrest the supply of water and all nourishment ceases.

The same is the case with animals. Not only is water necessary for the constitution of their bodies, but all the substances which maintain animal heat, and which nourish the animal tissues, are dissolved and carried into the body by the aid of water. Nay, even when these substances are oxidised and changed, and are no longer fitted for the purposes of life, they are carried off from the system by the aid of water.

Man is no exception to this law. His body is composed mainly of water. The constituents of a man's body, weighing 150 pounds, might be easily divided into five parts, each of which could be placed in an ordinary-sized pail, holding 32 pints. All the solid constituents of a man's body would go into one pail, whilst the other four would contain the water. In more accurate figures, the solid constituents of a man's body, weighing 154 pounds, would be 43 pounds of solid and gaseous matter, and 111 pounds of water.

Neither the water nor the other constituents of a man's body are permanently retained. Life does not so much consist in the chemical changes which our daily food is undergoing as in the destruction of the tissues which are formed out of the food. Blood, muscle, and nerve formed from the food of yesterday become the source of active life to-morrow. That which to-day is available flesh is to-morrow rejected from the system. The water of the tissues is removed at the rate of from 80 to 100 ounces a day. Of this 50 ounces pass off by the kidneys, 30 by the lungs, and 14 by the skin. Of course season affects these quantities, and the larger the person and the greater the drinker, the more water is got rid of.

Not only is water necessary to the sustaining of the human body, but all other constituents are taken into the body by its agency. All our food naturally contains water. Here is the result of analyses of various articles of food. One hundred pounds contain the following quantities of water:—

Potatoes	75 lbs.
Cabbage	92 „
Flour	14 „
Rice	13 „
Bread	44 „
Milk	86 „
Beef	50 „
Mutton	44 „
Fish	78 „
Eggs	80 „
Cheese	40 „

From this list it will be seen that all our ordinary food contains water. But this is not enough to carry the various substances we use as food into the system. The sugar, the starch, the oil, the fibrin, and albumen must all be dissolved and carried into the system by the aid of water. Hence we partake of beverages. We drink tea, coffee, chocolate, beer, soup, and other fluid foods. In all these cases we are merely flavouring the water which it is necessary for us to take in order to enable the stomach to dissolve and take up the more solid forms of our food.

The quantity of water contained in the meat, bread, and vegetables of which man indirectly partakes in his food is about one-fourth of the quantity of water he requires for daily consumption. The only food which is ever substantially supplied to him, and this only in his infancy, which requires no addition of water, is milk. Potatoes contain nearly as much water as milk, and those who live entirely on potatoes require but little water. A curious proof of this was observed during the potato famine in Ireland. It was observed as a remarkable fact that in their great poverty the people of Ireland were consuming larger quantities of tea, coffee, and sugar, which might be regarded as luxuries. The increase, however, of these luxuries depended on the fact that whilst the starving people of Ireland were fed with rice, flour, and other dry food, as substitutes for the potato, they were obliged to have recourse to water for drink. As in the case of all other civilized people, they preferred their water flavoured, and partook of tea and coffee sweetened with sugar.

Water, then, being essential to the life of man, let us inquire into its natural sources and fitness for the *dietetical* uses of man. Water exists naturally upon the surface of the earth, in its interior, and in the atmosphere. The heat of the sun daily carries enormous quantities of water into the atmosphere, from whence it is precipitated upon the earth in the form of snow and rain. This percolates into the earth from whence it comes again in the form of springs, and may be reached by digging wells. Much of this water finds its way into rivers with the rain from the surface, and these empty themselves into the ocean. As the water in its course from the atmosphere to the sea dissolves all soluble matters it meets with in the earth, and these are not evaporated again, sea water is a strong solution of various salts. The principal of these is chloride of sodium. The following analysis of sea water from the German Ocean gives the other constituents :—

Solids in 100 parts of water ... ... 3·15

Chloride of sodium in 100 parts of solids			... ...	77·78
Chloride of magnesium	„	„	„	8·12
Chloride of potassium	„	„	„	0·97
Chloride of calcium	„	„	„	1·39
Bromide of magnesium	„	„	„	0·47
Sulphate of lime	„	„	„	3·49
Sulphate of magnesia	„	„	„	6·79
Carbonate of lime	„	„	„	0·56
Silicate of soda	„	„	„	0·25
				100·00

The sea also contains oxygen and carbonic acid gas. Sometimes the water which passes into the earth comes up highly charged with mineral constituents. When such waters cannot be ordinarily drunk, and are supposed to be medicinal in their action, they are called *mineral* waters. Such waters have been the foundation of the reputation and fortunes of such places as Harrowgate, Cheltenham, Leamington, in this country, and Ems, Kissengen, Wiesbaden, Carlsbad, and others on the Continent. Many of the constituents which are in excess in these waters are the same as those contained naturally in the sea. Some of them, however, contain ingredients not found in the sea water in its normal condition at all, as the salts of iron and sulphuretted hydrogen.

Besides the substances enumerated, which are inorganic, sea and mineral waters contain naturally a certain quantity of organic matters, arising from the decomposition of the animals and plants which live in them.

The sources of water for the ordinary drinking purposes of man, are rain, springs, or rivers. Water obtained from these sources holds in solution certain substances, but not in so large quantities as the sea or mineral waters. Of the water ordinarily drunk, rain water is the purest. On account of its dissolving soap with facility, it is called *soft* water. When waters contain lime, they form an insoluble substance with soap, and are on that account called *hard*. As we use the word, a *soft* water is not necessarily a water containing a small amount of saline matters, but one that contains little or no lime. Rain water, as it falls from the clouds, contains no saline matters, unless we apply this term to the almost infinitesimal quantity of carbonic acid and ammonia which it is known to contain. When collected in the country in the open air, it is almost absolutely pure; but as it is usually collected for human use, it is liable to various impurities. Thus, in London and in large towns, it is collected from the tops of houses, and by the time it enters the cistern or water-butt it contains a variety of impurities. It acquires carbonaceous matter from the smoke in the air, and small quantities of carburetted and sulphuretted hydrogen, so that its flavour is very disagreeable from that cause. From the roofs of houses it also collects another quantity of impurities, and especially the dung of birds, as of pigeons, jackdaws, and sparrows, which invariably frequent the roofs of the houses in our great towns. So that rain-water, although freest from saline matters of any water, is seldom collected in such a condition as to be fitted for dietetical or cooking purposes.

The other two sources from which our great towns are supplied are springs and rivers. London with its vast population is principally supplied from the river Thames, whilst Manchester, Liverpool, and Glasgow are supplied with spring water. No general comparison can be made between the purity of spring water and river water, as some springs come up highly charged with objectionable constituents, whilst some river waters present a purity unrivalled by any spring water.

The great object of every civilized community should be to secure pure water, whether it be derived from springs or rivers. Water is so essential to life, and its deficiency or impurity may be so destructive of health, that the supply of water ought never to be dependent on individuals. Like the air which we breathe it is amongst the first gifts of God to man, and no man has a moral right to stand between his fellow-creature and this essential of his existence, and all arrangements which exclude the poorest from a healthful supply of this agent should at once be modified Not only, however, is there a scanty supply of this necessity in many of our large towns, but great ignorance prevails of what are the conditions which render it impure.

Water itself, the chemical compound of hydrogen and oxygen, of which we have spoken, is always pure; but it has great chemical powers and unites vigorously with other agents, dissolving them and holding them in solution. It is these substances which act injuriously on the human system, and which, not being required there, produce diseased actions in the body in order to get rid of them.

Spring and rain water do not materially differ from each other in composition. It may, perhaps, be generally stated that spring water presents a tendency to impurity from excess of inorganic constituents, whilst river water presents the same tendency from the presence of organic constituents. It should, however, be recollected that under the term spring water two very different sources of supply are indicated. In one case it is applied to springs which burst from rocks and are discharged into rills on the surface of the earth, or to water obtained from deep borings in water-holding rocks; whilst in another case it is applied to water from wells sunk a few feet into the soil, and from which water is drawn by means of pumps. Such wells are frequently sunk in the midst of towns, and are the depositories of all kinds of organic filth from the percolation of drains and surface water of the district.

In referring to the constituents, then, of spring and river waters, which are likely to render them impure, I shall speak of them together. These substances may be divided into *inorganic* and *organic*. The inorganic are saline matters which are dissolved by the water in passing through or over the rocks of the earth, whilst the organic substances are the result of plants and animals which have lived in the water, or have been introduced by the contact of the water with dead organic matter.

The following table will give some idea of the composition of rain, spring, and well water in this country:—

NAMES OF SUBSTANCES.	GRAINS IN A GALLON. 1 River Thames.	2 River Severn.	3 Spring at Cheltenham.	4 Well at Clapton.	5 Well at Cheltenham.
Carbonate of Lime	12·75	3·36	8·46	15·09	35·2
Carbonate of Magnesia...	1·02			13·97	
Sulphate of Iron	0·45	3·68	3·01	15·32	25·9
Sulphate of Potash	0·66	1·00	0·50	6·74	4·0
Sulphate of Soda.........	2·00	0·45	0·50	10·77	2·0
Chloride of Soda	1·10	1·84	0·41	11·46	25.6
Chloride of Calcium ...	1·75				
Silica	0·27	0·88	0·80	0·24	0·1
Total grains in a gallon...	20·00	11·21	13·68	73·59	92·8

The columns 1 and 2 give the principal inorganic constituents of two of our great rivers; 3, is a fair specimen of spring water from which the town of Cheltenham is now supplied; 4 and 5 are examples of surface wells. Much purer and much more injurious waters than these are now supplied to many of our towns. The supply from the Dee in Aberdeen contains but five grains of saline matter in the gallon, whilst the spring water from Loch Katrine supplied to Glasgow contains but three grains of impurity in a gallon; on the other hand, there are pumps in the streets of London supplying water with 200 grains of impurity in the gallon.

It may be asked here what may be regarded as the maximum of saline matter that may be taken without injury? This, however, is a difficult question to answer. At a sanitary congress held at Brussels in the year 1851 it was agreed that a good and safe drinking water should not have more than 35 grains of dissolved constituents in the gallon. This must, however, in a great measure depend on the nature of the salts, as we know that chloride of sodium and carbonate of lime are comparatively uninjurious, whilst the salts of magnesia in small quantities do harm. Various experiments of the quantities of the more common constituents of water which may be safely taken have been given. The following may be regarded as an approximation to safe quantities. It may be said that a gallon of water should not contain of

Carbonate of Lime more than	...	20 grains.
Sulphate of Lime ,,	... ...	3 ,,
Salts of Magnesia ,,	... ...	3 ,,
Chloride of Sodium ,,	... ...	20 ,,
Carbonate of Soda ,,	... ...	20 ,,
Sulphate of Soda ,,	... ...	5 ,,

These are the ordinary constituents of water, but water from special circumstances may be rendered impure by very small quantities of other constituents. A water with very small quantities of iodide or bromide of sodium, the salts of iron, lead, copper, arsenic, or antimony, might soon become very injurious to health. The presence of large quantities of gases has also been objected to. Ordinary drinking water contains in the gallon about six cubic inches of nitrogen, 2½ of oxygen, and 5 to 7 of carbonic acid. These may be absent or in much larger extent without being injurious. There is one thing that should be recollected with regard to these gases, and that is, that they render the water sparkling to the eye and fresh to the taste, and that they are entirely got rid of by boiling.

It is almost impossible for persons who have not had a chemical education, to analyse water with that degree of accuracy that would enable them to judge of any particular ingredient there is in water. Nevertheless, I think it quite possible for intelligent people so to test water as to come to a tolerably correct conclusion with regard to its purity. Most persons use their senses before drinking water. Thus its colour and transparency may be at once detected by the eye. So accustomed are we to the true colour of water, that we at once detect any departure from its natural appearance. Blue water, green water, yellow water, are immediately detected and regarded as unnatural. The transparency of water is also recognised as a natural and necessary property. Indeed, water should be at once rejected, unless its turbidity is known to depend upon some uninjurious agent. The taste of water is still more generally known. Any departure from the insipidity of water is usually detected. Such departure should be noted, and any strange tasting water should be rejected. The sense of taste is essentially connected with that of smell, and sometimes the exercise of taste and smell may tend to the detection of impurities in water. Even the sense of *touch* may be employed in the investigation of water, as the action of hard water, or water containing much lime, is very appreciable to the touch in the process of washing the hands by the aid of soap.

Organic impurities are of more importance than inorganic, as they seem to be sources of much more fatal and dreadful forms of disease. It seems to be difficult to convince many intelligent people of the danger of drinking water containing organic impurities. They refer to the practice of taking organic matter in water in the form of soup and broth, and think this is sufficient to refute the evidence that the organic matters in water can do any harm. I think the evidence that organic matter in water, under certain circumstances, is injurious and destructive of health is abundant, conclusive, and satisfactory. I gave an instance at the beginning of this paper; I now give another. In 1849 cholera prevailed in the districts supplied by two of the water companies of London—the Southwark and Lambeth Water Companies. In that year both companies obtained their supply of water from the Thames below Teddington Lock, and from parts of the river subject to great impurities. In 1853 the Lambeth Company had removed its source of supply from the river to a point above Teddington Lock. In that year cholera prevailed again in the district supplied by both companies. It was found that, during four weeks of 1853, there were 334 deaths; of these 286 deaths occurred in 40,046 houses supplied with water from the Southwark Company, which still obtained its supply from the impure source below Teddington Lock, whilst in 26,107 houses supplied by the Lambeth Company, there were only 14 deaths. This case was thoroughly investigated at the time by the late Dr. Snow, and the correctness of his conclusions was confirmed by the Registrar-General. In this instance there can be no doubt either that the injurious water did directly communicate the germs of the disease, or that it predisposed the inhabitants of the district who partook of it to the attacks of the poison of cholera.

Now let us see if we can in any manner account for the presence of matter in water which can exert such an injurious influence on the system. If we take four or five pints of water and allow it to stand for a few hours, and then decant off the clear part, leaving a small portion behind, say from two drachms to an ounce, and then place a drop or two of this remaining portion under the microscope, we shall find we have a variety of living beings. They are chiefly unicellular organisms belonging to the animal and vegetable kingdoms. The number and variety of them will give an approximation to the impurity of the water. They are of different kinds, and where the filaments of fungi and certain forms of animalcules abound there the water may be regarded as most impure. As a test example, sewer-water may be taken, and when similar organisms to those found in sewer-water abound, the specimen examined is to be most suspected. In making this investigation care should be taken to have fair samples of the water. The purest water, if exposed for a long time to the air in close vessels, or taken from pipes or cisterns which have a long time been exposed to the air, will present these organisms. The only fair way of using this test is to take a specimen of the water from the mass of the water in the river, reservoir, or other source from which the water is obtained. The purest water, even distilled water, when kept for a length of time exposed to the air, will contain the filaments of fungi and a variety of animalcules. Under any circumstances, living organisms can only be regarded as indicating the probability that water in which they are found contains organic impurities, which by their decomposition have afforded the elements on which the lower plants and animals are nourished. That they are more abundant in water contaminated with sewage and other organic impurities shows the importance of using the microscope as a test of the purity of water.

It is, however, the death of these living organisms and the introduction into water of animal and vegetable matters in a state of decomposition that renders water impure and dangerous to the health of those who drink it. Both river and spring waters are liable to these contaminations. In recent times our rivers have been rendered impure by making them common sewers of the great towns and cities situated on their banks. It is in this way the Thames has become polluted, so that the legislature first interfered and required that all water companies supplying London should obtain their supplies above Teddington Lock, beyond the influence of the sewage of London, and subsequently passed an Act for the carrying of all the sewage of London down to a point in the Thames in which it could not be brought by the tide into the river as it passed through London.

It must not, however, be supposed that all organic matter produced in rivers or thrown there remains unchanged. No sooner is organic matter placed in water than a process of oxidation commences, by which the nitrogen of the organic matter is converted into nitric acid, and the carbon into carbonic acid. This is effected by the oxygen, which is naturally found in all water exposed to the air. As long as there is sufficient oxygen in the water to oxidise the organic matter, so long the water remains free from those constituents which are injurious to health. It too often happens, however, that all the oxygen is exhausted and the organic matters enter into a state of change in which dangerous compounds are generated. What the nature of these compounds is, neither the chemist nor the pathologist has been able to demonstrate. It is, however, well known that water under these circumstances becomes tainted; that it gives off sulphuretted hydrogen and other stinking gases; and that, when taken internally, it produces sickness, diarrhœa, and other symptoms of disease. It does not follow that these conditions will occur at all times. In cold weather water holds more oxygen in solution than in hot weather, and it frequently happens that it is only at certain seasons that water holding organic matters in solution becomes injurious. Heat not only robs water of its oxygen, but favours the rapid decomposition of animal and vegetable matters, so that it is most frequently during the warm season of the year that water becomes injurious.

How to detect *dead* organic matter thus becomes a matter of great importance. Now, it has been found that this matter exists in water in two forms—suspended and dissolved. The suspended organic matter can be detected with the microscope. It is generally heavier than the water and settles at the bottom, although sometimes it floats on the surface. In either case it may be detected by the microscope, and is found to consist of minute, shapeless particles of animal and vegetable bodies. When these are in any appreciable quantities, the water is impure.

When the organic matters are in a dissolved state, the microscope can no longer detect them. Chemical agents must be employed for their discovery. The method adopted by analytical chemists is to weigh the total solids of the water left by evaporation, and then to incinerate the portion left, and to weigh again. The matter lost by incineration is then regarded as organic matter. There is, however, another method, which, although less accurate, is easily applied, and requires no chemical knowledge to use and appreciate. This process consists in adding a quantity of permanganate of potash or soda to the suspected water. All the permanganates have the power of giving a beautiful purple colour to water. A small quantity of organic matter will, however, decompose the permanganate and prevent its colour from being developed, or annihilate it if it has been once established. The best method of procedure in this case is to employ a solution of permanganate of potash of a known strength. I employ a solution of five grains to the ounce of distilled water. Half a pint or a pint of the water to be examined may be then taken, and five drops of the solution of permanganate added. According to the colour left in the water will be the amount of organic matter it contains. The quantity of permanganate may be so arranged as to give an approximation to the quantity of organic matter in the water when such a quantity of permanganate has been added as to afford the slightest possible tinge. If a large quantity of permanganate has its colour thus destroyed, a large quantity of organic matter must be present. But for ordinary testing it is better perhaps to have a standard water,—pure distilled water, or some water whose quantity of organic matter has been ascertained,—and then compare the colour it gives with the permanganate with the colour given by the suspected specimen of water.

By this test the impurity of water from dissolved organic matter can be ascertained with very tolerable accuracy. It should, however, be recollected that it is not applicable to water containing iron, as a very small quantity of iron will discolour the permanganate. The quantity of organic matter in waters supplied to our great towns differs from one to three or more grains per gallon. Suspicion should be aroused when the organic matter of water reaches two grains per gallon.

Having said thus much with regard to the nature of water and the means of ascertaining its impurities, the question may be still dealt with a little further as to the nature of the evils produced by drinking impure water. I have more particularly referred to cholera, and the evidence of a large number of other cases is most convincing as to the production of cholera by impure water. It is a question to be determined as to whether any specific cholera poison is conveyed into water which thus gains access to the individuals attacked, or whether the organic matter of the water is in such a state as to bring on a state of the system in those who drink it to predispose them to receive the poison of cholera from other sources. At any rate, our sanitary action in this case should lead us to cover both issues of the question, and protect ourselves from the direct poison of the water as well as its predisposing action.

With regard to other diseases of the bowels, there is abundant evidence on record to show that diarrhœa is produced by drinking impure water, and that such cases of diarrhœa have only ceased when pure water has been had recourse to for drinking and cooking purposes. The organic impurities are much more likely to produce this effect in warm weather, for reasons I have before alluded to; and this is the reason why diarrhœa is so much more frequent in summer, and why water should be much more carefully watched in the warm seasons of the year.

Of the various forms of contagious fever which attack the inhabitants of this country, there appears to be little doubt that the fever known as typhoid fever is propagated by means of water. Whether this fever can be produced *de novo*, by poison in water or in the air, is still a question amongst medical men; but that occasional epidemics of this fever are produced by drinking water there is no doubt in the minds of medical inquirers. Dr. Budd relates the instance of a ball at Cowbridge which was attended by from ninety to a hundred people. Of these more than one-third were laid up with typhoid fever. In this case there was satisfactory reason to believe that the water served at the ball was contaminated. Numerous instances, showing the occurrence of this disease in families after drinking impure water, are recorded, and there can be little doubt that it is one of the forms of disease that is propagated by the agency of impure water.

Another set of diseases are malarious fevers, which are known to be produced by drinking impure water. I might add a long list of other diseases which, on competent medical authority, are known to have originated in impure water. I will only allude to the attacks of parasitic animals. It is well known that various creatures inhabit the human body, especially the class of worms. A large number of worms pass their cystic or larval stage in the bodies of other animals. The eggs of these creatures are, in the majority of instances, introduced by the agency of water. Amongst the contents of impure waters the microscope reveals the eggs of the entozoa, and there can be little doubt that the germs of cystic worms and hydatids are introduced into the human system by the agency of impure water. I hope, however, that I have said enough to show how necessary it is for our welfare that pure water should be supplied for daily use, and I have now to speak of some of the practical measures that should be adopted for the supply of pure water. This question naturally divides itself into the public supply of water to towns, and the private supply of families.

With regard to public supplies of water, it will be seen that water neither from rivers nor springs is certainly pure. When water is taken from a river to supply a town, especially when the river receives sewage, every precaution should be taken to reduce the organic matter to the lowest possible quantity. It is undoubtedly desirable in a country like our own, where such large masses of the community, as in London for instance, must depend on water from rivers, that the legislature should pass some stringent Act, forbidding the diversion of the drainage of our large towns into rivers at all. When it is recollected that this must eventually be a gain to the country, by compelling the deposition of the sewage in the soil, where it must necessarily become a source of wealth, it is to be hoped that there will no longer be supineness or ignorance enough to prevent legislation on this very important subject.

But even water from springs may be contaminated. Springs are often situated in highly cultivated agricultural districts, among populations utterly negligent of the distribution of the water-courses that flow through them, and may thus reach the population which they supply with water, highly charged with organic matters. It is only by proper filtration at the works, by which the water is supplied to towns, that danger can be obviated, either in the case of water supplied by rivers or springs. It is a consolation to know that through the care and intelligence exhibited by a large number of our water companies, water is now supplied to many of our large towns of an unexceptionable character. This is remarkably the case in London, where the water of the Thames, receiving the sewage of several large towns in its course, can nevertheless be supplied in a state of purity, which will bear comparison with most other large towns in England. It is necessary that a vigilant eye should be kept on the nature of this supply, and in London we are undoubtedly indebted to the monthly analysis of water supplied by the Thames companies, published by the Registrar-General, for the maintenance of the integrity of our water.

There are, however, large numbers of the population who are not within the reach of our public supplies, and who are obliged to have recourse to pumps and wells, ponds, rivers, and ditches, for the water which they drink. Such persons cannot be too cautious in the employment of the water they are compelled to take. Wherever water is of a doubtful character, then filtration should be had recourse to. The filtration of water can be effected by passing it through sand, pebbles, sandstone, sponge, and charcoal. Of these agents, charcoal is most efficient. Filters made with charcoal are now manufactured on a large scale, and are, in most instances, efficient means of rendering impure water pure. Such filters should be employed when waters are of a doubtful character, and only filtered water should be used for drinking purposes.*

Where, however, filtered water cannot be had, it should be known that one of the most effectual means of purifying water is submitting it to boiling. This does not get rid of all its inorganic constituents, but it effectually destroys organic matters. It is undoubtedly insipid (which may be obviated by passing it through a gazogene), but it is better to drink the most insipid of water, than run the hazard of drinking water charged with organic impurities.

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* There are two classes of filters sold for public use, one of which is constructed of loose charcoal, and performs its duties admirably; whilst another class is made of charcoal more or less compressed and moulded, which prevents the due purification of the water.

When water is otherwise good it may be rendered impure by the carelessness and indolence of those who use it. Thus a water, which drunk when first drawn from the cistern, pipe, or well in which it stands is perfectly harmless, may become injurious by standing for days in the same vessel. It frequently happens that water-bottles, pitchers, and mugs, in which water is habitually kept, are never cleansed, and the daily deposit of organic matter at the bottom will at last become so great as to render the water putrid. It is in this way, by the negligence of servants and others, that waters otherwise free from objection are found to become tainted, and I have known attempts made to cast doubt on the quality of the whole supply of a town from individual cases of neglect and ignorance.

In these remarks on the purification of water, I have more particularly directed attention to the removal of organic impurities, as those which are most injurious to health. I would, however, refer to the fact that, when waters contain a large quantity of carbonate of lime, which is always held in solution in carbonic acid, this salt of lime may be got rid of by neutralizing the carbonic acid with pure lime. This process, originally suggested by Dr. Clark, of Aberdeen, has been successfully employed to soften hard water, and may be advantageously employed, both for removing the organic impurities as well as the carbonate of lime.

It should also be remembered that storing water in leaden cisterns, and conveying it through leaden pipes, may lead to a dangerous contamination with lead.

The interest of the public in pure water is not alone confined to its use as an article of diet. For cooking, washing, bathing, and manufacturing purposes the purest water is the best. Each one of these subjects might be made the topic of practical suggestions, but as my limits will not allow me to add more on the subject of pure water, I would say, in conclusion, that for all purposes for which water is employed by man, the purer it is the better it is adapted for his use.

ON THE NATURE AND DIAGNOSTIC VALUE OF RAPHIDES AND OTHER PLANT-CRYSTALS.

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WHEN no physiologist doubts that the life of the entire plant is the sum of the life of its numberless constituent cells, and we consider how much intimate structure has been made subservient to the various branches of natural history, it seems amazing that the value of raphides and their organic vesicles as truly natural characters in descriptive botany should not have been sooner discovered.

But so much confusion has prevailed in the use of the term raphides, in the statements of the occurrence of the facts, and from the paucity and uncertainty of those facts, that the total neglect of them as diagnostic characters in the orders or genera of the vegetable kingdom has been unavoidable.

In truth, how could it be otherwise, when we find all crystalline formations in vegetable cells included under one term, in our latest and best book of microscopic anatomy? The prevailing confusion seemed likely to be perpetuated unless corrected by an appeal to the book of nature. "There are few of the higher classes," we are told in the former book, "which do not contain raphides; they are very abundant in the herbaceous structures of the Monocotyledons, generally, and especially those of the *Araceæ*, *Musaceæ*, *Liliaceæ*, &c.; they also abound in the *Polygonaceæ*, *Cactaceæ*, *Euphorbiaceæ*, *Urticaceæ*, &c., among the Dicotyledons. They are usually found only in the interior of the cavities of cells, but in some cases they occur in the intercellular cavities,—perhaps, however, accidentally. They may occur in almost any part, but are found most extensively in the stems of herbaceous plants (Monocotyledons in general and *Cactaceæ*); they also occur in the bark and pith of many woody plants (Lime, Vine); leaves likewise frequently contain them in vast quantity (*Araceæ*, *Musaceæ*, *Liliaceæ*, *Iridaceæ*, *Polygonaceæ*); also sepals (*Orchidaceæ*, *Geraniaceæ*); in the Rhubarb, and also in *Umbelli-*

feræ, they occur extensively in the roots; and they abound in the autumn in the base of the bulbs of the Onion, and other *Liliaceæ.*"* How could descriptive or systematic botany hope for assistance from such vague materials?

Nor is the matter mended when we turn from our most valuable compilations to the results given in works of original research; for the facts still appear no less ambiguous, no more available as natural characters, if indeed they were ever supposed capable of affording any useful characters at all. Thus, even such an eminent observer as Schleiden† summarily dismissed the subject; for he says, "The needle-formed crystals, being a combination of a very long prism with an octaedron, lie together in bundles of from twenty to thirty in a single cell, which they entirely fill up, and are present in almost all plants. . . . . . Inorganic crystals are seldom met with in cells in a full state of vitality." And, though Payen had shown that certain crystals in plants are always produced in a special tissue provided for the purpose, the celebrated German botanist Link, and our own Edwin Quekett,‡ came to the conclusion that "raphides in plants are nothing more than accidental deposits, like calculi in animals;" while the excellent histologist, John Quekett,§ especially cites the Tulip, Onion, and Anagallis among the examples of raphis-bearing plants. Again, according to some of our current and best treatises on organography, "raphides are to be found in any liliaceous plant, in the spermoderm of *Pandanaceæ,* and in the little whitish spots observable beneath the leaf-skin of the Marvel of Peru."

Truly, the whole subject thus seemed little more than one of the pretty "marvels of the microscope;" curious, indeed, and not without some hidden meaning or importance, though destitute of any apparent rule, perhaps rather connected with the aberrations of disease than with the regular and healthy state of the plant, and nowise presenting the appearance even of any sure phenomena likely either to be useful in, or to have any conceivable connection with, descriptive or systematic botany.

Now, the truth is that the first list above cited is a heterogeneous assemblage of plants, chiefly affording sphæraphides or other crystals; for not half of the orders specified therein are fruitful of true raphides. Thus the sphæraphides of *Cactaceæ*, *Geraniaceæ*, &c., were either confounded with or not properly distinguished from the raphides of *Araceæ* and *Orchidaceæ;* while in this last order raphides are by no means confined to the sepals; and there are certainly extensive groups of Monocotyledons remarkable for their want of raphides. Probably the starch-sticks of *Euphorbiaceæ* * were mistaken by Rafn and others for saline crystals. Nor could I ever find true raphides at all in the Tulip and Onions; though the bulb-scales of a section of these last-named plants constantly afford beautiful prismatic crystals of oxalate of lime and magnesia.† And as to "any liliaceous plant," the spermoderm of *Pandanaceæ* and the little whitish spots on the Marvel of Peru, which last is a species belonging to the order *Nyctaginaceæ*, there are many Lilies regularly devoid of raphides; while these acicular crystals and their cells abound, more or less, throughout the frame of the members of the orders of which only those spots of one species and the spermoderm of another group are noticed.

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* "The Micrographic Dictionary," p. 547.

† "Principles of Scientific Botany," translated by Dr. Lankester, pp. 6 and 91.

‡ Lindley's "Introduction to Botany," 3rd edition.

§ "A Practical Treatise on the Microscope." 8vo. Lond., 1855. Page 433.

And in all the species yet examined by me, of these and other orders presently to be mentioned, so deep and extensive is this character, that it may sometimes be proved in the ovule, and regularly in the seed-leaves, and more or less diffused thenceforth throughout the plant; nay, even maintaining its constancy where the art of floriculture has modified or destroyed some of the recognized and most essential characters, as shown, for example, by the bundles of raphides within their much larger and very soft cells of the numerous double-flowered varieties of the Balsam. In short, so far from raphides being accidental deposits, the sum of my researches on this point is to the effect, on the contrary, that they are really such an intrinsic result of the plant-life, from the cradle to the grave, of the species in question, as not only to be truly indicative of an essential part of the very nature of those species, and consequently of relative value in the description of their characters, but capable also of affording, in certain cases, a diagnosis at once as original and prevailing, between plants of allied orders, as any other single character yet employed by systematical botanists for this purpose.

Hence the belief that, as regards the raphidian subject, important method might displace trifling confusion. And so no wonder that I should cheerfully respond in the affirmative to the request of the learned editor of the POPULAR SCIENCE REVIEW for a contribution on the nature and diagnostic value of raphides and other crystals in plants. And this is undertaken with the more pleasure as affording an opportunity of ventilating the question by an abstract of my researches thereon, promulgated piecemeal in various scientific journals,* during the last few years, and now to be presented with the substance of a few more observations, either since made or not heretofore published. Thus, referring for more particular and complete details of evidence to those journals, especially to the *Annals of Natural History*, a better digest or more general survey of the subject may be given in the POPULAR SCIENCE REVIEW than is at present extant elsewhere. Nor is this the only object now; for I am not without the hope of exciting through its pages more attention to an interesting and valuable department of scientific botany, likely to be fruitful in beautiful and useful results, and with the additional attraction of novelty and facility in the acquisition.

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* *Annals of Natural History*, March, 1862.

† *Ibid.*, April and June, 1864.

Let us then, adopting Lord Bacon's recommendation to review our knowledge and transplant it into the minds of others as it grew in our own, see how the importance of raphides as natural characters became evident to me. During many years I had been making dissections under the microscope, and notes of the results, of every plant collected in my rural excursions. These researches were undertaken for the purpose mainly of comparing the intimate structure of plants and animals, and for learning incidentally what good diagnoses might thus be found between allied orders, genera, and species. In the natural sciences the study of difference or contrast may be more difficult and not less important than the study of affinity or analogy; and the complaint by that illustrious philosopher, of the comparative neglect of difference in anatomy† is still applicable to modern science. Since the discoveries of Schleiden and Schwann, important advances have been made in both directions, including the valuable characters of the bone-cells and intimate structure of the teeth of animals, as expounded by the late John Quekett, the late Alexander Nasmyth, and Mr. Tomes. And it had been shown‡ that certain animals may not only be distinguished by the red corpuscles of their blood alone from other species of the same or allied orders, but from the other members of the vertebrate subkingdom generally; nay, that the most universal single diagnostic between the two great divisions of that subkingdom is in the blood; that is to say, while a nucleus regularly exists in the red corpuscles of oviparous vertebrata, such nucleus is as regularly wanting in the red corpuscle of Mammalia. Hence the divisions *Vertebrata pyrenæmata* and *Vertebrata apyrenæmata*.*

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* See *Annals of Natural History*, *Quarterly Journal of Microscopic Science*, and *Seemann's Journal of Botany*.

† Lord Bacon's Works, 4to., i. 68.

‡ See my Appendix to Gerber's Anatomy, dated 1842, but published or printed in the preceding year.

Little use has been made in descriptive botany of the distinctions afforded by intimate structure in allied flowering plants; and my own observations had not been long prosecuted when many examples were found of the truth of Schleiden's remark as to how little hope there is, without a study of the fundamental principles of development, of much further aid to systematic botany from mere anatomy. Yet it soon appeared that minute anatomy would occasionally afford good diagnoses in the pith-cells, leaf-cells, or pollen, between some species of one genus of such vascular plants as *Juncaceæ*,† *Hymenophylleæ*,‡ and *Ranunculeæ*;§ and it was not before a large heap of my notes had been collated, that raphides were at all thought of in this point of view; for they had not been particularly looked after, having been merely noted as they happened to be seen, long before their significance as natural characters was even suspected. But when all those notes of raphides had been picked out, it was very unexpectedly discovered that they would come under certain orderly arrangements. Thus not a single instance of any species belonging to the orders *Onagraceæ* and *Galiaceæ* was without a note of raphides; while of the neighbouring orders raphides were noted in no species whatever. And, conversely, a single order, *e.g.*, *Hydrocharidaceæ*, in which raphides were never seen at all, would be surrounded by orders in which raphides ever appeared abundantly. Thus it was that this subject forced itself on my attention; and then repeated experimental trials soon proved that raphis-bearing is an essential and intrinsic, a distinct and characteristic phenomenon throughout the life of certain plants, and withal clearly a sure and constant result of that life; while the same character was as constantly wanting in still more plants. Raphides were proved to exist in the ovule,|| to be always present in the seed-leaves, and thenceforth throughout the leaves and a large part of the intertexture of the frame of the species belonging to such orders as *Onagraceæ*. Hence the inquiry was continued, with the results of which the present memoir contains an epitome.

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* College Lectures, reported in *Medical Times and Gazette*, 1862–63; and the "Hunterian Oration" for 1863.

† *Annals of Natural History*, December, 1863, plate VII.

‡ *Ibid.*, October, 1863, and *Seemann's Journal of Botany*, same date.

§ *Annals of Natural History*, ser. 3, vol. xvi.

|| *Annals of Natural History*, November, 1863, fig. 1, p. 366.

Independently of the interest of raphides in abstract botanical science, it may be added that I have found the characters which they afford useful in little embarrassments of the garden. Thus it proved at once easy and convenient, as well as novel and interesting, to pick out, simply by the raphidian character, seedlings of the exotic *Onagraceæ*, now so commonly cultivated and admired, from seedlings of other orders; and seedlings of *Mesembryaceæ*, which had also been sown in pots, and got confused with other pots of young *Crassulaceæ*—both orders of succulent flowering plants—were as surely and quickly distinguished in like manner. This kind of practical diagnosis also proved equally good in plants at every period of their existence, and even shapeless fragments of their dead or rotting stems were thus distinguishable. A reserve bed, in which had been planted, and intended for removal when required, a Willow-herb, various Evening Primroses, Phloxes, Campions, and Rockets, had got into troublesome confusion, when nothing was easier than to discern all the *Onagraceæ* by the profusion of raphides in the roots and subterranean buds, before growth had revived in the winter and early spring. Only there was a tough creeping root or underground stem with its buds, certainly neither a Willow-herb nor Evening Primrose. What this could be was a puzzle; and so it was put into a pot for future observations, where in due time it became a fine specimen of Woodruff, a plant belonging to the raphis-bearing order *Galiaceæ*. Would any other diagnostic character, yet used in our botanical systems, have been available in such cases?

"There are," says Professor Lindley,* "principles which experience tells us the systematist must keep in view, and most especially that of regarding of importance whatever appears to be constant in its nature among nearly allied species; that nothing which is thus constant can be considered unimportant, for everything constant is dependent upon, or connected with, some essential function; and, therefore, all constant characters, of whatever nature, require to be taken into account in classifying plants according to their natural affinities." Now, when plainly seeing the truth of these remarks, how can we regularly find such beautiful objects as raphides and their delicate organic cells in nearly allied species of one order of plants, and an equally regular absence of the same objects from the species of other and neighbouring orders, without clearly perceiving also that we have thus realized a character of which that illustrious botanist had so far sketched the foreshadow, though no systematist has yet grasped its substance? At least I have never found even the slightest hint of it among the short diagnoses and long descriptions of the orders, genera, and species, either in any local Flora or more extensive Prodromus, or System of the vegetable kingdom. Yet those books are arranged according to the natural method; and how truly raphides form a fragment of this method we have already shown.

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* "The Vegetable Kingdom," 8vo., pp. xxvii.—xxviii.

And, in addition to their truth and naturalness, we shall soon adduce further evidence of their value and constancy. While granting that the most fundamental and universal elementary organ of vegetables is the cellular tissue, how can we avoid the admission that their cell-life must possess a correlative importance? And how is the investigation of this subject to be prosecuted without a careful attention to the results of that life? Surely we shall never be able to comprehend and realize the mysterious plans of Nature, and those infinite details by which she has marked, for our interpretation, the true affinities and contrasts of the members of her system in the vegetable kingdom, unless we use every diligence in our attempts to read her own characters. And how are we to do this without a recognition of the phenomena of the cell-life as part and parcel of the natural history of every plant? And though raphides and their cells form but a small fragment of this great argument, it is a portion which, like some others, has been strangely overlooked; and this chiefly from a neglect by systematists, admirable as their labours have been, of a comparative view of the structure and functions, affinities and contrasts of the cells of allied flowering plants; in short from a lamentable deficiency in the cell-biography of species.*

Now, then, we are prepared to see how this field, hitherto left well nigh barren, may be made very fertile, and the cultivation so pleasant and profitable as to promise an additional source of rational amusement and information to persons in the country; and in which the ladies of their families might not only participate, but reasonably hope by such participation to assist in enlarging our knowledge of botanical science.

Indeed, besides their mere scientific value, these pursuits offer in themselves alone a precious reward. They beguile the dull routine of professional and other employments, cherish gentle thoughts and calm desires, and multiply and refine our enjoyments; they endear many a rural walk with delightful associations of "each lane, and every alley green, dingle, or bushy dell, and every bosky bourn from side to side;" they may soften solitude or affliction; they must impress us with meek and touching lessons of the means of happiness so bountifully spread before us, and of how cheaply some of our best pleasures may be purchased. And, above all, while thus teaching us to look for the good and the beautiful in surrounding objects, and helping us to the true riches—those large and best possessions—of contentment and thankfulness, they may incline our minds to the grateful habit of "looking through nature up to nature's God."

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* See Dr. Lankester's remarks in the *Quarterly Journal of Microscopical Science* for October, 1863.

Though we too often get into the mist of error, nature is ever true. And hence, in reply to frequent requests for a sight of my collection of raphides, I have always referred to Nature's own collection, for this is the best; and there, at least, we may find "employment of idle time, then not idly spent." In fact, a chief object of the present paper is to show how she invites us gratuitously, how the visit may be paid with little trouble and much profit, and how even this lowly study of raphides may be made at once subservient to science and to some of our best enjoyments.

To this end we have only to look into and compare the cells of the many plants besetting our country rambles, and for which purpose an achromatic object-glass of half an inch focal length will suffice. The form and contents of the cells may be best seen in fine sections of the stem, leaves, and other parts; but as such sections are not to be made without practice and skill, they may be dispensed with at first, and another way employed, rough and ready indeed, yet likely to be rewarded with interesting and useful results, provided the pursuit be steadily continued. We have simply to dissect with needles, or scrape or mash with a penknife a fragment of the plant-tissue in a drop of water on a glass object-plate, and place it, either covered or not with a thinner bit of glass, under the microscope, when many of the vegetable cells will be seen with their form and contents perfect, and others more or less broken, and their contents escaped into the water; and we must also examine them alone without this liquid. So easy is such sort of examination that it may be completed in less time than that required for the present description thereof, thus contrasting favourably with the more difficult process required for displaying the anatomy of many seeds, and with the further advantage that the character we are in search of is always present in the species, while its seeds and organs of fructification are very likely to be absent. For example, if the problem be to distinguish a Balsam from a plant of another and nearly allied order, mere shapeless fragments of the leaves or stem, without the slightest aid from the recognized characters of the fructiferous organs, would be sufficient for the purpose. And many pleasing and useful observations may be extended to the flowers, fruit, and other parts. The red berries of the Black Bryony and Cuckoopint may thus be instantly distinguished from those of the Red Bryony and Guelder-rose. So, too, of fresh barks and roots, and numerous officinal drugs and vegetables. Examples of this kind might be extensively multiplied; but it is better for the student to find them out for himself, after having mastered the principles.

Now, if we thus often examine the cells in the leaves, in parts which are modifications of leaves, and the stem, fruit, root, and other organs, of some of the flowering plants most commonly seen in our walks—say a Willow-herb or Bed-straw, a Loosestrife or Honeysuckle—we shall get remarkable results. Indeed, so plain and simple, so significant and beautiful will they prove, that our first feeling may well be one of surprise that such characters have not been long since discovered, and usefully realized in descriptive or systematic botany. While we find raphides constantly abounding in the former two plants, in the latter two we shall as constantly find raphides wanting, and this in examples now purposely chosen from neighbouring orders of the British Flora. And having thus, as well as by repeated independent trials, found the constancy and truth of this character, how can we avoid the conviction that to the first two plants Nature has assigned, as an essential and intrinsic function by a structure of organic cells, the office of raphis-bearing, while to the last two plants she has not appointed that same office or structure? And so this will appear to us not merely as an arbitrary or technical distinction, but as a truly regular and natural difference. What may be the exact value of such a character is another question, which can only be determined after far more time and talent have been devoted to the inquiry than I have been able to bestow. As every botanist well knows that even the highest physiological or anatomical characteristics are not without exceptions, so we may be sure that they will be found not less numerous in this new character. Irregularities of this kind occur in the Palms, and in other orders to be noticed presently.

But it is with the rule, as far as it is yet known, that we are now concerned; and so comes the question of the nature and distribution of raphides in flowering plants. And we must first give a description of, and explain the sense in which, on the present occasion, we use the terms raphides, crystal prisms, and sphæraphides. The etymologies are given in the *Annals of Natural History* for September, 1863.

Raphides are the well-known transparent and colourless needle-shaped crystals, occurring in a bundle of about twenty, within a delicate, soft, pale, oval or oblong cell, which they seldom completely fill, being more frequently shorter than it. They are for the most part so loosely connected together in the bundle, that their movements on or displacements from each other are as free as needles in a packet; and they are apt to escape, under gentle pressure, from the cell during their examination. Each raphis gradually tapers or vanishes to a point at both ends, and commonly presents no faces or angles when viewed with the aid of a low magnifying power; for whatever angles a raphis might have if formed separately, these may be more or less checked or lost from the effects of attrition. The raphides of the bundle are also loosely contained within their cell, which is commonly larger in its inside than the bundle of raphides, sometimes twice or even thrice the size of that bundle, and generally larger than the neighbouring tissue-cells. Occasionally the raphides escape regularly, under the slightest manipulation, from either end of the cell; these are sometimes distinguished as biforines. Raphides vary much in size in the same plant, and more in different species and orders. In the following measurements, all vulgar fractions of an English inch, only average sizes are expressed, and L. stands for length, T. for thickness. Raphides of *Impatiens*, L. $\frac{1}{500}$, T. $\frac{1}{16000}$; of *Œnothera* and *Epilobium*, L. $\frac{1}{285}$, T. $\frac{1}{12000}$; of *Galium* and *Crucianella*, L. $\frac{1}{300}$, T. $\frac{1}{15000}$; of *Tamus*, L. $\frac{1}{124}$, T. $\frac{1}{5000}$; of *Urginea*, L. $\frac{1}{27}$, T. $\frac{1}{1200}$. As to their composition, in *Epilobium*, *Galium*, and officinal *Sarza*, it appears to be phosphate of lime; in *Mesembryanthemum* and *Heliconia*, oxalate of lime and magnesia; in *Veratrum*, *Richardia*, and *Colocasia*, oxalate of lime.*

Crystal prisms are also acicular forms, but seldom occur more than two, three, or four in contact, and then closely side by side, as if partly fused together; they are more often strewed singly throughout the plant-tissue; and sometimes, as in the bulb-scales of the Shallot, they form crosses. The very same magnifying power under which the crystal prisms are plainly seen to possess three or four faces and angles will fail to show any such angles or faces on a raphis. Nor do the crystal prisms gradually taper at the ends to points, like a raphis, but their tips are either pyramids with the base corresponding to the shaft, or like a carpenter's chisel, or wedge-shaped, or cut off obliquely from angle to angle or from face to face; or the ends may be truncate, an appearance often caused by fracture. These crystals, when they lie in contact, are not easily separable from each other, nor from the tissue in which they are seated; and when the cell can be seen, it is closely investing the crystal. Of the four-sided prisms, the faces may either be all equal, or two of them broader than the other two; and of the three-sided prisms, a transverse section of the shaft may be either an isosceles or equilateral triangle. A longitudinal cleavage through the centre of two opposite faces of the equally four-sided prism would form that with two sides broader than the other two; and a longitudinal cleavage, diagonally from angle to angle, of these two square shafts would give the equilateral and isosceles triangles. Crystal prisms are commonly larger, sometimes smaller, than raphides, and vary in size in the same plant, and still more in different orders: in the root-stock of Florentine Iris they have an average length of $\frac{1}{25}$, and thickness of $\frac{1}{532}$ of an inch; in the leaves of *Iris pumila* and *Gladiolus insignis*, L. of $\frac{1}{50}$, and T. of $\frac{1}{800}$ of an inch; in the middle layer of the testa of *Silybum*, L. $\frac{1}{500}$, T. $\frac{1}{2666}$; in the ovary-coat of *Carduus*, L. $\frac{1}{333}$, T. $\frac{1}{4000}$; in the same part of *Centaurea nigra*, L. $\frac{1}{1000}$, T. $\frac{1}{6400}$; in the bark of *Quillaja*, L. $\frac{1}{160}$, T. $\frac{1}{1600}$; in the bulb-scales of *Allium*, L. $\frac{1}{200}$, T. $\frac{1}{800}$ of an inch. Dr. Davy found them in the *Iris* composed oxalate of lime; in *Allium*, of oxalate of lime and magnesia.

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* See the details of Dr. Davy's examinations, and a notice of Dr. Maclagan's, in the *Annals of Natural History*, June, 1864, p. 508.

Sphæraphides are more or less rounded bodies, often spherical, chiefly made up of crystals or crystalline matter, commonly opaque and whitish, unless where the ends of the crystals project at the circumference and appear transparent. These ends often give a stellated appearance to the sphæraphides, which are as frequently with the projecting points much shorter, and as frequently merely rough or granular on the surface. The jutting tips are many times sharp ends of prisms, and portions of the prismatic shafts may be often seen broken out of the sphæraphides, by pressure, on the object-plate of the microscope. Sphæraphides vary much in size in the same plant, and still more in different orders;—in *Chenopodiaceæ*, *Sesuviaceæ*, *Haloragaceæ*, the shrubby *Cinchonaceæ*, and many other orders, commonly about $\frac{1}{1300}$ of an inch in diameter; $\frac{1}{1200}$ of an inch in *Pistia*, and very much larger in some *Cactaceæ*. They are smaller than their cells, and often occur so regularly therein, so studded throughout the cellular network, as to make part of a beautiful structure. This I have depicted, under the name of sphæraphid tissue, from Lythrum,* which includes the similar forms long before described by Quekett in the Elm and Cranesbill. He called them conglomerate raphides; but they have been more frequently confounded with or included under the single name of raphides. The sphæraphides of certain *Moraceæ* and other *Urticales* have been named cystoliths and crystal glands on the Continent. They have been regarded by chemists as composed of oxalate of lime.

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* *Annals of Natural History*, September, 1863.

And now, concerning the distribution of raphides in the Phænogamous Flora of the world, space will only admit of a very short notice of very fragmentary results; and for the same reason a further consideration of the sphæraphides and other crystals must be deferred.

Of the class Endogens, taken in lineal sequence, we find the first two and extensive orders devoid of raphides, which appear constantly, and for the most part abundantly, as well as for the first time in the class, in the orders *Pistiaceæ, Typhaceæ, Araceæ,* and *Pandanaceæ;* then irregularly in the Palms; and are regularly absent from *Hydrocharidaceæ, Naiadaceæ,* and *Zosteraceæ.* Next appearing again abundantly and regularly in the immediately succeeding orders—*Bromeliaceæ, Hæmodoraceæ,* and *Hypoxidaceæ;* occurring, with some curious exceptions, in *Amaryllidaceæ* and *Iridaceæ,* often with numerous crystal prisms, and these most abundant and remarkable in the last-named order. In *Musaceæ* the raphides are more or less plentiful; but are scarce, if not generally wanting, in *Zingiberaceæ* and *Marantaceæ. Burmanniaceæ, Orchidaceæ,* and *Commelinaceæ* abound in raphides, which are deficient in *Xyridaceæ,* while crystal prisms are plentiful in *Philydrum. Juncaceæ* is an order devoid of, or very scantily supplied with, raphides; and the order *Orontiaceæ* (except *Acoreæ*) abounds with them. Several *Melanthaceæ* afford raphides and sphæraphides plentifully, and others are devoid of raphides; the *Pontederaceæ* contain raphides and crystal prisms. Of *Liliaceæ* some sections, or parts of sections, are regularly devoid of raphides; and other sections, or parts of sections, as constantly pregnant with them: crystal prisms also occur rather frequently in this order. Finally, *Butomaceæ, Alismaceæ,* and *Juncaginaceæ* are wanting in raphides.

Of Dictyogens I have never found a plant without raphides; only these are mostly replaced in *Roxburghia* by crystal prisms.

In Gymnogens I have seen no raphides at all.

Among the class Exogens raphides occur plentifully, and often very characteristically, in *Vitaceæ, Balsaminaceæ, Nyctaginaceæ, Phytolaccaceæ, Mesembryanthemum, Onagraceæ, Galiaceæ,* and the herbaceous *Cinchonaceæ.* The crystal prisms of *Quillaja* and *Guaiacum* are well known.

These results are in many respects very remarkable. A few of them will here be noticed. Of the Endogens, the first two orders, which constitute a large part of Professor Lindley's

Glumal Alliance, and the last three orders, which form the whole of his Alismal Alliance, are regularly wanting in raphides. And thus this extensive and characteristic deficiency returns, like a circle, into itself; analogous to what takes place with other and higher characters in the classification of the vegetable kingdom. Proceeding through the flowering plants, in lineal series, the whole of the Aral Alliance proves pregnant with raphides; the succeeding, or Hydral Alliance, barren of them; while they appear again in the Narcissal Alliance. And when we observe the curious exception of the exraphidian Acorus among the raphidian *Orontiaceæ*, it must be borne in mind that this plant belongs to the last and distinct section of the order; and though admitted by Professor Babington under another raphis-bearing order, *Araceæ*, Acorus stands in Professor Lindley's "School Botany" as the type of a different order—*Acoraceæ*—there placed between the two orders *Juncaceæ* and *Juncaginaceæ*, both of which, like Acorus, are destitute, or nearly so, of raphides.

The Dictyogens, so regularly affording raphides, stand between the two groups, Alismales and Gymnogens, wanting in raphides. The Yams, an order of Dictyogens, have been shown to possess, in some very important points of structure, no obscure resemblance to the Birthworts, an order of Dicotyledons. If, however, we compare the cells in the leaves and other parts of a Tamus and Aristolochia, the abundance of raphides in the former plant, and their absence in the latter, will present a remarkable difference not hitherto noticed between these orders.

Of the Exogens, in lineal sequence, the order *Vitaceæ* is completely isolated, by the possession of the raphidian character, from its congeners. The last and least order of the Berberal Alliance, *Cyrillaceæ*, is the only one of which I have not examined species. In the very centre of this Berberal Alliance, which consists altogether of no less than seven orders, stands *Vitaceæ;* and in no plant of which Alliance, excepting this single order, have I yet been able to find raphides, while in every species which I have examined of *Vitaceæ* raphides were abundantly found. And so, too, taking it in the middle of its circle of affinities, as set down by Lindley, this order still presents the same difference. Thus, we have a good example of the diagnostic value of the raphidian character in exotic Exogens. And this is not the only interesting result of this examination of *Vitaceæ;* for Leea is now found, in the possession of the raphidian character, maintaining its affinity with the order, and so helping to justify Adrien de Jussieu and Lindley in still retaining that genus in its old place, notwithstanding the opinion of other eminent botanists to the contrary. Surely, had these botanists looked into the intimate structure of the plants in question, the beautiful raphidian cells of Leea must have pleaded its affinity with an order distinguished, as just described, by this very same natural character. *Balsaminaceæ*, *Nyctaginaceæ*, and *Phytolaccaceæ*, are likewise characterized as raphis-bearing orders; succeeded, after a long interval, by the like character in *Onagraceæ*, *Galiaceæ*, and the herbaceous *Cinchonaceæ;* while it isolates the immense genus *Mesembryanthemum* from all its allies.

Raphides abound too in the herbaceous species of the old *Rubiaceæ*, whether with or without stipules, and are replaced by sphæraphides in the shrubby or ligneous plants. This order has been divided, chiefly on the disputed point of the presence or absence of stipules, into *Cinchonaceæ* and *Galiaceæ*. In the event of a reconstruction of these orders, systematic botanists would have to determine what may be the relative value of stipules and raphides in this question.

It is noteworthy that, in the foreign Flora, we find raphides in several exogenous trees and shrubs, as may be well seen in *Nyctaginaceæ*, but of which I have yet found no example in such woody plants of our native Flora.

The results, less perplexed by the multiplicity of objects, may appear more distinct and interesting to British botanists in their own Flora. Referring to Professor Babington's excellent "Manual of British Botany," the leading phenomenon that meets us among the Dicotyledones is the curious conflux and limitation of raphides to the three orders, *Balsaminaceæ*, *Onagraceæ*, and *Galiaceæ;* a valuable diagnostic character, which he may well adopt in future. How so many of our trees and shrubs, destitute of raphides, though affluent of other crystals, came to be cited by authors as raphis-bearing plants, arose from the confusion of terms already explained. And as to the Monocotyledones we find more than half of them, including the Grasses, regularly devoid of raphides. The *Dictyogenæ* still all raphis-bearers, and standing between two orders—*Coniferæ* and *Hydrocharidaceæ*—lacking this character, while this last-named order appears between *Dioscoreaceæ* and *Orchidaceæ*,* two orders in which, on the contrary, raphides abound; the main or parallel-veined group of Monocotyledones still beginning, still ending, with orders wanting raphides. *Typhaceæ*, *Araceæ*, and *Lemnaceæ*, all raphis-bearing plants—with the reconcileable exception of Acorus—and yet these three raphidian orders standing closely together, and immediately preceded and succeeded by the two exraphidian orders *Alismaceæ* and *Potamogetonaceæ*. Among *Liliaceæ*, though the Onions, the Tulip, Fritillary, and Lilies are regularly barren of raphides, the Star of Bethlehem, the Squills, the Blue-bell, and the Grape Hyacinth are as regularly pregnant with raphides; characters likely to be usefully extended and defined in the revision which both the whole order and its sections seem to require.

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* Of this order our pretty Lady's Tresses (*Spiranthes autumnalis*), to be found flowering during late summer in upland pastures, and the Marsh Helleborine (*Epipactis latifolia*), blooming a few weeks earlier in damp places, are good plants in which to observe the bundles of raphides within, and much smaller than, their pale, soft cells. In the Lady's Tresses the raphidian cells may be well seen, without disturbance, in their natural situation, through the semitransparent margins of the bract-like stem-leaves. An old dried portion of a leaf of this plant, now before me, after having been

Finally, a multiplication of independent inquiries may be expected to correct the details and inferences, which are only submitted provisionally, throughout the present memoir; and it is hoped that the whole question will successfully invite, if not truly merit, that further research, by which alone my observations can be either restricted or confuted, extended or confirmed. But surely, simple and plain evidence has now proved the novelty and importance of the subject; and that, without a discriminative recognition of raphides as an intrinsic and essential, distinct and characteristic result of the cell-life of several groups of plants, no fair and complete history can be written of the Vegetable Kingdom.

EDENBRIDGE, KENT, *Sept.* 5, 1865.

soaked for some hours in water at the temperature of the air, and gently pressed between the object-plate and a thinner bit of glass, shows the raphidian cells admirably. So do numerous growing plants of other orders of Exogens nearer at hand, such as the Mesembryanthemums, so commonly cultivated as window-plants, the Fuchsia, the Vine, and the Virginian Creeper. At this season, too, the berries of raphis-bearing plants, as the Asparagus, Fuchsia, Black Bryony, and the Cuckoo-pint, are interesting objects for examination. The raphidian cells of some of those fruits are depicted in the *Annals of Natural History* for November, 1863.

ON LAKE BASINS.

BY PROFESSOR D. T. ANSTED, M.A., F.R.S.

THERE is no subject of general interest in geology and physical geography that has more attracted the attention of the scientific world, and been the cause of more lively discussion of late years, than that of the origin of Lake Basins. Some geologists, deeply impressed with the grandeur of ice-action, and the unmistakeable marks of force exhibited by it, have assumed that all the deepest gorges and hollows now occupied by water have been scooped out by glaciers. Others, equally affected by the evidence of the erosive power of water in its fluid state, have thought that, either by floods or by the effects of great rivers, these hollow spaces have been first made and then left full. Geologists having strong faith in crashes and violent upheavals and depressions, are quite willing to accept as sufficient causes for all lake basins the faults, axes, and other disruptions and disturbances of strata effected rapidly and convulsively, as they believe, during the elevations of mountains and the formation of continents. Thus there is ample ground for discussion, and it must be confessed that in some respects the battle is something like that between the Neptunists and Plutonists in the earlier days of geology, when neither party had much opportunity or desire of appealing to nature to decide, but was none the worse combatant because he was more inclined to appeal to arguments than to discover facts.

Under these circumstances, perhaps, a short account of some of the principal lake basins of the world, with a view to show the varieties that exist, the circumstances under which they exist, their peculiarities of form and position, their magnitude and depth, and the form of their bottoms, when known, will form an interesting and useful introduction to a short notice of recent theories on the subject, and the conflicting views of some of our best modern geologists as to their origin.

The great ocean itself is but a vast lake basin, the whole of whose bed lies below a certain level, or, in other words, at a certain mean distance from the earth's centre. This condition is clearly due to the fact that at the surface of the earth a number of mixtures and combinations of elementary bodies exist in a state of permanent equilibrium, and in the three states of earth, water, and air, these states being themselves due to peculiar distribution and circulation of heat, light, electricity, gravitation, and chemical agency proper to the position of the earth in a state of permanent equilibrium, in that part of the great system of bodies occupying space, in which we find ourselves to be. It is impossible to deny this, and equally impossible not to see that the form of the bottom of this chief of all lake basins is, in the logical sense of the word, an *accident*. Certainly, the essential fact of water resting on land is not in any way the cause of the form of the ocean floor.

But, besides the general depression which is, under all circumstances, occupied by water, and which may fitly be called the open ocean, there are numerous smaller seas, more or less nearly enclosed, and many depressions of all conceivable forms and dimensions in that part of the solid mass which rises above the mean level of the sea. Many of these communicate by channels with the open ocean, and their level necessarily approximates closely to that of the sea. Of this kind the Mediterranean is a familiar example. The Black Sea, again, opens into the Sea of Marmora, and that into the Mediterranean, and is only dependent on the ocean through two intervening bodies of water. The Sea of Azof opens only into the Black Sea, and is thus dependent on the sea in a very indirect manner. The levels of these seas are different, and the state of saltness of their waters is very different from the ocean; but still they are inland seas, and not lakes of the more distinct and well-marked kind. The Caspian Sea is another step removed from the ocean. It is a vast sheet of salt water; but the proportion of salt it contains is much smaller than in the open sea, whilst its level is more than eighty feet below that of the ocean. This great lake has always received the drainage of two great rivers (the Volga and the Ural), but is probably nothing more than a partially-dried and separated part of the ocean, which once came in from the north. The Dead Sea is a small but very remarkable sheet of water, whose surface is upwards of eighteen hundred feet below the sea. It is, however, apparently the remains of a larger sheet, and was probably at one time a part of the Red Sea. Owing to its peculiarities of position and separation from the Red Sea, and partly also to the enormously greater evaporation than supply from its surface, but partly to the influx of springs connected with volcanic emanations, it has attained its present character. I might mention many other instances, but these are sufficient for my purpose. They show the connecting link between seas and lakes, and remind the reader that some of those lakes that are most different from the sea in the nature of their water contents and their geographical position, and that are at present in the far interior of great continents, are still nothing more than portions of the great ocean accidentally cut off from communication.

I must now request the attention of the reader to the outlines in the accompanying plate, which show the forms of various lake basins. Among them are outlines of the Black Sea, the Caspian Sea, and the Dead Sea. Among them also are the Zuider Sea, in Holland; a little salt lake called Tchokrak, in the Crimea; and an inlet on the coast of New Zealand. All these are more or less exceptions to the common and limited idea of lake basins: and it will be seen that they differ somewhat in form from most of the other lakes, many examples of which are as familiar as they are typical. Whatever may be the cause of the form of the oceanic basins, the same causes may be referred to as sufficient to explain these open lakes communicating, either now or formerly, with the sea. Thus the Mediterranean, the Black Sea, and the Sea of Azof, all now connected by water passages, are yet perfectly distinct as basins. Each has its well-marked limits; each its peculiarities of depth and form of bottom; each its peculiar condition of saltness; each, above all, is distinctly marked by physical features connected with the geological structure of the district around; and in this is the clue that may enable us to solve the problem of the origin of the phenomena, and the link that connects these basins with those of fresh-water lakes in other localities. I may add, that in these and many other like cases the smallest geological accident might separate them entirely from the open ocean, and reduce them to the state of lakes.

The reader may find it useful to be reminded of the peculiar features just alluded to. A vast mountain chain exists in the old world, broken in various places by wide gaps, and produced rather by innumerable points and centres of elevation, acting in a linear direction, than by any continuous force. This great chain is double. A northern line ranges from the Pyrenees through the Alps and Carpathians, the mountains of the Crimea and the Caucasus to the Altai group, and the chains that extend eastwards to the Pacific. A southern line commences with the Atlas mountains, and ranges eastwards to Arabia, and thence by the Himalayan chain to the south of China. It is between these two chains that the great inland seas occur. Many of them have once communicated freely with the ocean, and some are still open; but some also have at certain geological periods been occupied by fresh water almost exclusively. It is clearly impossible to understand their physical geography without studying carefully the geology of their coasts.

Let us pass on now to consider the various kinds of lake basins, or rather the lake basins that appear to exist under different circumstances. The first group, being marine basins, or those that still contain water more or less salt, and whose level is similar to or below that of the sea, must probably have had direct communication with the sea at one time, and were therefore parts of the oceanic basin. Most of these are broad and open, but some, as the Red Sea and the Dead Sea, and some lakes or sea channels in mountain districts, are elongated, narrow, and tortuous, and often very deep. They are known by various special names—as fjords in Norway, friths in Scotland. These are well worthy of study. They almost always occupy crevices in hard rock, and sometimes, though not always, they certainly appear to be connected with faults or axes of disturbance. Such are some of the phenomena of that class of lake basins whose relation to the general depression of parts of the earth and elevation of other parts is most manifest.

There is another class of lakes and lake basins whose origin is apparently quite different, but not less clear. In large open flat spaces on wide plains, and on steppes, we occasionally find pools. These are generally shallow, and owe their water contents to occasional rains that fall in the neighbourhood, or to floods that come down periodically. Of this kind, are the great lakes of Africa, recently discovered and described by Dr. Livingstone, Burton, Speke, Grant, and others. Such is also the Lake Tchad, in Central Africa (see the form of this lake in the plate). Such again is Lake Torrens, in South Australia, whose waters according to the earlier describers, were almost illimitable, but which would suddenly shrink almost to nothing. In Europe, the Lakes Ladoga and Onega, between Finland and Russia, are remarkable examples (see plate), and the innumerable lakes of South Sweden, and the interior of Finland, are of the same nature. The Platten See in Austria, and some of the lakes in Ireland (as Lough Neagh), partake of this character. In all, there is a total absence of any other physical peculiarity in the district around, than the existence of wide flat plains, or low undulating ground. They occupy depressions in the plains, and the nature of the rock is of small importance. Almost all rocks, in fact, have surfaces more or less irregular, when they have been worn by exposure to similar causes, and it is very easy to understand that such depressions are occupied by the excess of rain-water or river-water that remains on the surface after the ordinary drainage has carried off all that it is capable of doing. These lakes or pools are larger or smaller according to the rate of evaporation, and they occasionally disappear altogether, leaving no mark. We may then see the bottom of the basin—the bed of the pool, and the depression in which the water was contained is often quite undistinguishable by the eye. Sometimes, indeed, as in limestone countries, the water sinks into the earth by crevices in the rock, and only exists as a lake when these are choked. Such a condition often results in malaria, owing to rapid evaporation through decayed vegetable matter.

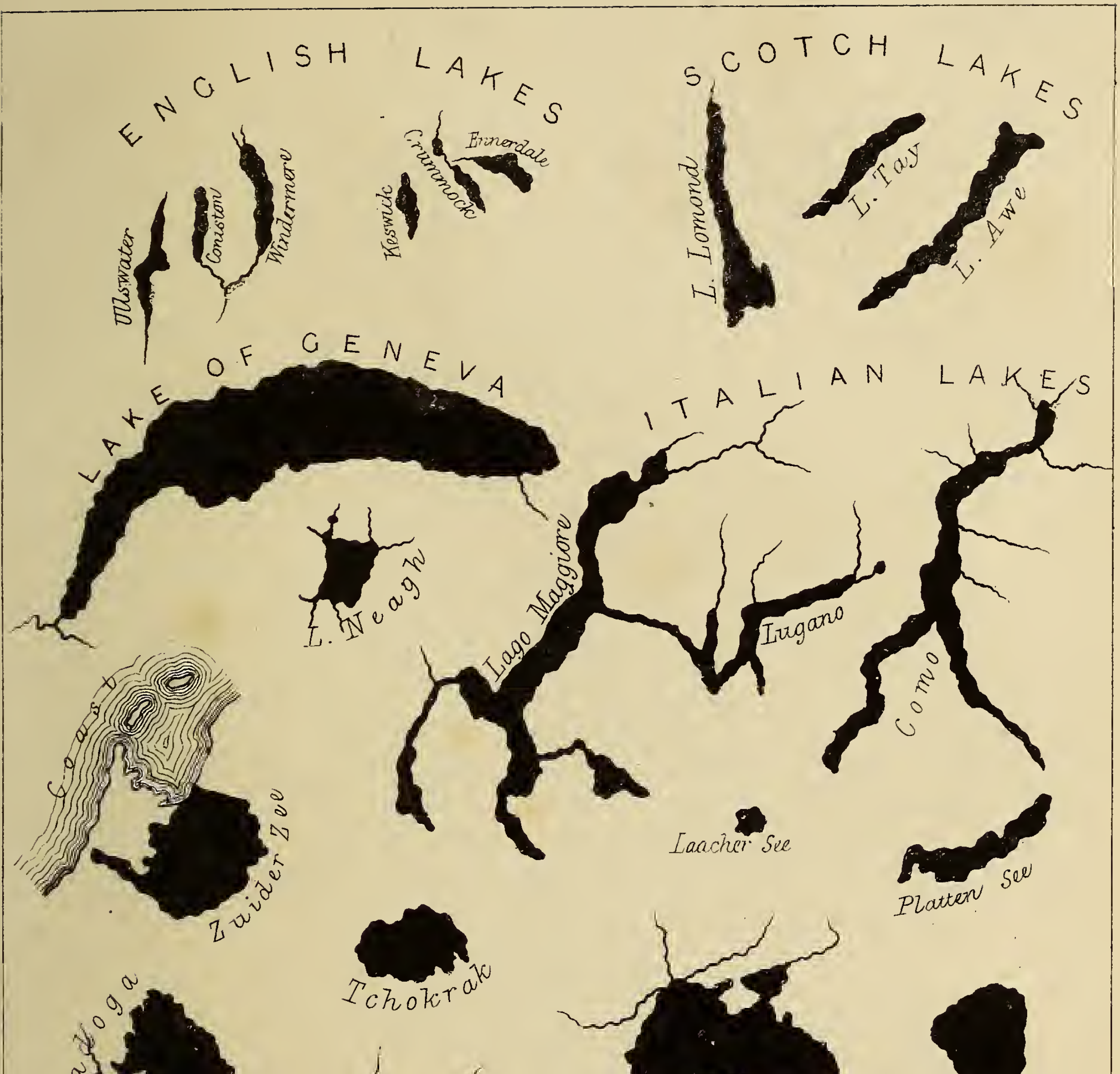
A third class of lakes is illustrated in the plate, by the Lago di Bolsena, in Tuscany, and the Laacher See, near Bonn on the Rhine. There are round dark deep pools of clear and cold water, and are quite removed from the marine basins on the one hand, and from ordinary ponds or lakes on the other. If the water were emptied they would be like cups. They are the craters of old volcanoes. Bolsena is upwards of twenty-six miles in circumference, and is as remarkable for the volcanic rocks that surround it, as for the terrible malaria that rises from its banks. The Laacher See is much smaller, but apparently of the same nature. Of such lakes, there are also many, but they are confined to those districts where volcanic eruptions and disturbances have been observed in recent times, or where the rocks are such as to make it certain that they have been active at no distant period.

It is evident, then, that a large number of the lakes of the world offer nothing in their form or structure, or the circumstances of their existence, to justify a doubt as to their origin. They are the result of natural inequalities of the surface, inevitable when we consider how all land surfaces have been formed and modified. They represent such of these inequalities as have received and retained water.

But a large class remains. Mountain countries and parts of the world where there are or have been in recent geological times considerable changes of level caused by forces acting from below, present irregularities far more abrupt and irregular than the plains. One may travel from the Arctic circle to the shores of the Black Sea, without seeing any ridge or any tract of land rising a few hundred feet above the general level. In this wide area, which ranges from the Atlantic to the Pacific for a distance of at least fifteen hundred miles of latitude, there are no high lands. Here and there, indeed—frequently in the north, more rarely in the south, there are depressions of a few hundred feet or less below the general surface. Some of these are full of water; some contain a little water at the bottom; and some are dry, but water may generally be got by wells sunk a few yards into the rock at the bottom. Beyond these vast plains to the south, we come to another kind of country. Lofty mountain chains rise abruptly and grandly from the plains. Deep ravines and long lines of valley run up far into the mountain sides, narrow grooves conduct the traveller between elevated peaks, and a region is entered where there is only a partial, broken, and elevated plain or plateau, whose surface is irregular, but in a very different sense from that of the low plains to the north. This mountain country is altogether distinct in its character. Its depressions are different in form; its features are picturesque; its drainage is distinct; the rainfall upon it is generally greater, and owing to the form of the ground, the rain runs off from it rapidly. Such are the conditions of the country in which the lake basins occur whose history is one of the chief objects of discussion at the present time among geologists.

It must not be supposed that such lakes are confined to the great central east and west elevation, of which the Alps is a leading feature. The old mountain chain ranging north and south from Scandinavia, through the western countries of Europe, encloses a country in which mountain lakes also occur. Such are some of those of Norway and the deep fjords or inlets of its western coast. Such are the lakes and friths of Scotland and England. All exhibit the same general character; all exist in a country where the surface has been exposed not only to the running of water, but where the passage of ice either as glacier or iceberg has been traced by independent evidence, and within a very late geological period.

In North America again there is a vast tract of comparatively low land east of the Rocky Mountains, and north of the fortieth parallel of latitude, which resembles geographically the great plains of Europe, but is so different in climate as to offer few points of physical resemblance. Here the lakes that occupy the depressions are enormously larger, equally numerous, and more characteristic. Here are the vast waters of the Lakes Superior, Michigan, Huron, Erie, and Ontario all communicating with one another, and all ultimately communicating with the sea by the St. Lawrence. But these are true lakes. The plain is to a great extent a plateau or lofty plain, and the form of the lakes approximates them to that of the European lakes. New Zealand again (see plate) repeats their forms among groups of mountains very clearly marked and containing abundant ice, and among the loftiest of the Andes is a lake at an elevation of nearly 13,000 feet, whose magnitude in that position renders it almost an anomaly among the lakes of the world. (See the form of Lake Titicaca in the plate.)



W. West lith.

Forms of the Principal Lake Basins.

BRITISH MUSEUM NATURAL HISTORY

It might be thought from these accounts that lakes were universal phenomena, so numerous and varied are the localities I have had occasion to refer to. A little consideration will remind the reader that this is by no means the case. There are other districts equally extensive in which no sheet of fresh water worthy of the name is to be found. Thus throughout the greater part of South America the rivers carry off the waters that fall on the land without expanding into large sheets. In Australia there are hardly any lakes of importance, except those pools that dry up in the summer. There are few also in Northern Asia. Mountain lakes, or lakes such as we are now considering, are in fact very limited in range. They are numerous on the slopes of the Alps, and they abound, though on a far smaller scale, in the northern part of the British Islands. They are well marked in New Zealand, and there are good grounds for believing that many of the North American groups belong to the same series. But these occupy in all an exceedingly small area of the total amount of land. In the northern hemisphere the area is limited to small parts of the two great mountain systems, the old or north and south range affecting the western lands only, and the modern or east and west range affecting the whole mass of European, Asiatic, and North African land. The lakes connected with the elevation of the Andes are extremely few, though so remarkable for their elevation.

The great discussion concerning lake basins has been raised by some of our geologists familiar with a few small districts, but having only partial or hearsay knowledge of many important groups. All, probably, among the English geologists, are tolerably well acquainted with the British lakes, and many of them have seen something of the typical Swiss and North Italian lakes. The general forms of these are instructive. They are represented in the accompanying plate, where the English and Scotch lakes, drawn on a scale of 200 miles to an inch, may be compared with the Italian lakes, and the Lake of Geneva, on a scale of twenty miles to an inch. The actual detailed conditions of the basins, and the nature of the evidence that each affords in favour of any particular theory, are matters that require prolonged and careful study on the spot. At the same time there is much to be done by rapid travel in these countries, for a mere glance by those familiar with the results of aqueous, atmospheric, ice action elsewhere is highly suggestive, and sound observations may be made by those well accustomed to observe and compare.

The lake basins of the mountains about which discussion has chiefly been taken, are those of Geneva, in Switzerland, of Como, Lugano, and Maggiore in North Italy, of Scotland and the north-west of England, and of North America. Some of these are moderately deep, others rather shallow, some of gigantic dimensions, others only occupying a few square miles. The causes assigned for their origin are: (1) Denudation acting slowly in the ordinary way; (2) Glaciers pushed forward by a great body of ice from behind, and ploughing out large shallow hollows in soft rocks; (3) Natural valleys choked at some point either by detritus brought by water or ice, or by geological disturbances; (4) Natural hollows caused by faults, dislocations, and other results of elevation of the mass. It will not be denied that in a certain sense and to a certain extent each of these may be regarded as a *vera causa*. The question is, how far in a particular case any one of these agencies, as, for instance, denudation or ice, has been engaged in completing or doing the essential part of the work. Professor Ramsay, following in the steps of some ingenious Swiss geologists, has gone so far as to teach that lake basins generally are due to the erosive power of ice, and to that power only. He is supported in some measure by Sir W. Logan, who believes that the great American lake basins are results of denudation, not of geological disturbance. That they and the rest of the great plains, as well as the mountains and hills of the Alps and of Northern America, besides those of Northern Europe, have been affected by denudation and by ice, may be said to be certain. That there has been enormous elevation to produce the mountains and remove the vast mass of material once accumulated on rocks now forming the topmost peaks, is as certain as that the peaks are there; and that there have been in the valleys huge glaciers, compared with which existing glaciers of the Alps are as nothing, is not less true. But neither is it less true that there has been great elevation; that great elevation, no matter how long it has taken to complete it, must have resulted from and taken place in obedience to mechanical laws, and that the production of fissures, of faults, of axes, and of occasional wide interspaces or valleys between rocks, is inevitable.

Now, if we look at any of those lakes that have been formed in mountain districts, we shall find that they occupy valleys or portions of valleys, having a distinct relation to the great mountain systems adjacent. The Alps on both sides abound in such valleys, and very marvellous they are, exhibiting marks that cannot be mistaken of disruption and of erosion; disruption originally producing crevices, and erosion tearing away, enlarging, and widening these natural clefts to such an extent that their original character is lost and obliterated.

The reader is requested to cast his eye over the various mountain lakes whose forms are delineated on the accompanying plate. The Lake of Como is long, straggling, and forked; the sister lakes have the same general features. They have numerous feeders, and several of them are connected by narrow clefts occupied by streams. The Lago Maggiore is 2,600 feet deep. All come down from the north, being nearly at right angles to the general east and west direction of the great mountain chain. All are narrow compared to their length, but their width is enormously too great to be due to mere mechanical disruption. The Lake of Geneva, on the other hand, ranges east and west, on a parallel to the mountain chain. It is a lake within the great area of elevation, on the north side of the high Alpine chain, and within the plateau of Switzerland. A score of lakes of the same general character are scooped out of the soft tertiary sandstones of the valley of Switzerland. But all who are familiar with Switzerland will remember the lofty mountain wall of hard rock to the south of the Lake of Geneva, the corresponding wall of the Jura, enclosing the Lake of Neufchâtel, the peculiar and well-marked vertical rocks that shut in many parts of the Lake of the Four Cantons, and the mountain sides that shut in the little Lake of Thun. I speak from recollection, and the memories of Alpine travellers will supply a score of similar illustrations. There is equal evidence of original disruption and subsequent degradation and erosion, both on a grand scale, neither of them sufficient alone to produce the results observable, but both combining. Thus the disruption has been followed by long-continued and even violent erosion, partly by water, and afterwards by ice. The result is seen in the mixed disturbance by mechanical violence and denudation, by the paring away of vast quantities of material once accumulated over the rocks at present forming the mountain tops. The Lago Maggiore is not very much above the level of the sea, and its depth is great enough to justify the assumption that some cause in addition to erosion has acted. The Lake of Geneva is scarcely excavated to the sea level. But there must have been some depression in all these and similar cases in addition to the vast elevation, which has not only lifted up the sea bottom to the height of fifteen thousand feet in the Alps, eighteen thousand in the Caucasus, and twenty-eight thousand in the Himalayas. Probably the difference of height between the Alps and the Himalayas—equivalent to a thickness of thirteen thousand feet of strata—may have been removed by this water action. But this has not been done rapidly, and it has not been done equally over the whole area. Parts that were soft have been pared only from the surface. Similar soft rocks beneath the surface have been undermined. Hard parts have been occasionally left. Some of the fragments of hard rock have helped to destroy long ledges of strata.

Thus it is that the history of lake basins is not quite so simple as may at first appear. There are many that, having been formed and filled during the action of some erosive force, partly water, perhaps, and partly ice, may seem due to the action of ice alone. It would not be safe to assert that ice may not in some cases have been the chief agent. But there are very many of similar form, and having identical physical characteristics, concerning which it may be said that their position on the earth's surface excludes this hypothesis. There are many districts where lakes abound, but where there is no proof, and indeed no probability, that ice has ever been present in large quantity. There are also lacustrine deposits among rocks where there is no evidence whatever of glacial action. The geologist and the physical geographer must carefully observe where observation is possible, and infer where there is ground for inference. Thus, when we find that some of the principal lake basins of America are scooped out of horizontal strata, on low anticlinal and synclinal axes, it is clear that so far as the hollows have been cut they may be due to denudation and erosion either by water or ice. When in the Alps we find lake basins in valleys parallel or transverse to the main directions of elevation, or along lines of fault, it is difficult to refuse belief that systematic fissures due to elevation have not had something to do with the phenomenon. Mountains are not indeed, in the sense and to the extent of the earlier geologists, the backbone of the earth, or the eternal and permanent framework upon and amongst which aqueous deposits have grown and attached themselves, like the flesh of an animal on its skeleton. There is no real or useful analogy of this kind. The rocks that form the nuclei of the great mountains are neither the oldest nor the most systematic; they are often, no doubt, the hardest, and in that case they owe their position to their greater resisting power, when all around them was carried away, slowly and gradually, by weather and water. But it is just because this is the case, because the present form and outline is the result of a long past history, including periods of movement and periods of rest, but a never-ceasing wear and grind, that we find phenomena so varied in some respects, so distinct in others, but all due to the same group of causes acting continuously and only modified by local circumstances.

The geologist and physical geographer must then accept, and have faith in, all natural causes, and he must not allow himself to attribute to any one an exclusive jurisdiction. He must admit and study the value of water and ice as real causes, but he must not deny that structure has in many, perhaps in all, cases, guided and governed the direction of the movement. He must be satisfied that lake basins, like other phenomena, are not to be accounted for by the assumption of one cause, but that they belong to the physical history of the globe, and result from those combinations that have also produced mountains, valleys, and plains.

EPIDEMICS, PAST AND PRESENT—THEIR ORIGIN AND DISTRIBUTION.

EPIDEMICS, derived from the two Greek words ἐπὶ, *among*, and δῆμος, *people*, are those diseases which for a time prevail widely among the people of any country or locality, and then, for a longer or shorter period, either entirely, or for the most part, disappear. There are few diseases to which the human race is liable that may not, under favourable circumstances, take on the epidemic form. For example, diseases of the organs of respiration are very apt to become epidemic, in seasons characterized by extreme coldness or dampness of the atmosphere, or by great and sudden alternations of temperature. In a strict sense, however, the term epidemics is not usually employed in reference to the diseases of individual organs of the body, but is restricted to those derangements of the entire system depending upon the absorption of some poison, or the action of some "influence," from without. In the latter class of maladies, the individual organs may become diseased, and the derangement of their functions may modify the symptoms resulting from the primary poison or "influence;" but then the local diseases are the secondary result of the general disorder of the constitution, and not the source and origin of all the mischief.

Some epidemic diseases possess the power of self-propagation, that is to say, the poison or influence may be communicated by infected persons to persons in health, and the disease is then said to be contagious,* while others are entirely destitute of any such property. Scarlet fever and small-pox are familiar examples of the former class; ague and influenza, of the latter.

It is still a vexed question whether a disease that is capable

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[*] The terms "contagion" and "contagious" are here used in their widest signification, and are applied in this essay to all diseases capable of propagation by infected individuals to persons in health.

of self-propagation can ever be generated *de novo.* It is maintained, on the one hand, that such an occurrence is as impossible as the spontaneous generation of plants or animals; while, on the other hand, it is argued that the poison of certain diseases capable of self-propagation may, under certain favourable conditions, be produced independently of any pre-existing cases of the disease. The comparison of a fever-poison with a spore or ovum is an ingenious, but a most delusive, argument. An epidemic disease springing up in a locality where it was before unknown, and where it is impossible to trace its introduction from without, is said to be not more extraordinary than the development of fungi in a putrid fluid. The argument, however, is founded on a pure assumption, for there is not a tittle of evidence to show that a fever-poison is of the nature of a spore or ovum. Air saturated with the poisons of various contagious diseases has been condensed and submitted to the highest powers of the microscope, but nothing approaching to a small-pox spore, or a typhus ovum, has yet been discovered. It is true that certain contagious diseases, such as scarlet fever and small-pox, can in most instances be traced to contagion; but, with regard to others, such as typhoid or enteric fever, it is in most instances utterly impossible to account for the *first cases* in any outbreak on the theory of contagion, while, at the same time, there is direct evidence that the contagious power of the disease is extremely low. The question is no doubt beset with many difficulties, and constitutes one of the most intricate problems in medical science. It is one, however, which can never be solved by entering on the discussion with a preconceived theory as to the close analogy, if not identity, of a fever-poison with an animal or vegetable ovum, nor by assuming that the laws which regulate the propagation of one contagious disease are equally applicable to all. Nature's facts are too often interpreted by human laws, rather than by the laws of nature. In the case before us, the natural history of each disease must be studied independently, and our ideas as to its origin and mode of propagation must be founded on the evidence furnished by that study alone, and irrespective of the laws which seem to regulate the origin and propagation of other diseases with which it has no connection whatever, except in the human mind.

At the present moment, when the subject of epidemics is attracting so much attention, it may be interesting to call attention to the more important diseases comprised under that head, and to point out some of the main facts connected with their origin and distribution. The principal epidemic diseases then are, small-pox, scarlet fever, measles, typhus, relapsing fever, Oriental plague, yellow fever, diarrhœa, typhoid or enteric fever, cholera, dysentery, ague and remittent fevers, influenza, the sweating sickness, and the dancing mania.

1. *Small-pox*, the most loathsome of all diseases, is believed to have prevailed in India and China from time immemorial. About the middle of the sixth century it is supposed to have been conveyed by trading vessels from India to Arabia, and the Arabian army at the siege of Mecca, in the year 569, was the first victim of its fury. From Arabia it was imported into Europe by the Saracens, and there is evidence of its existence in Britain before the ninth century. Before the introduction of vaccination, small-pox was one of the chief causes of mortality in all the countries where it prevailed, and even now it occupies a prominent place in our mortuary returns. During the twenty-four years 1838-61, 125,352 of the population of England and Wales, and 21,369 of the population of London, *died* of small-pox; or, in other words, 1 in 75 of the total deaths in England and Wales, and 1 in 63 of the total deaths in London, were due to this disease. Small-pox is not confined to any race or quarter of the globe. At the present day, its appearance can, in the great majority of instances, be traced to contagion. It is evident, however, that it must at one time have had an origin, and it is reasonable to infer that what happened once may happen again. Small-pox is known to attack many of the lower animals as well as man, and there are grounds for believing that it originated among the former, and by them was communicated to the human species. A careful study of epizootics—our ignorance of which has been disclosed by the present cattle plague—may ultimately reveal the mode of origin of the poison of small-pox. The disease varies greatly in its prevalence at different times. In other words, it is sometimes epidemic, at others not. Some of these epidemics are local; others are widely extended. All exhibit a gradual rise, culmination, and decline, the decline being always less rapid than the advance. It is difficult to account for the occurrence of these epidemics. They are independent of hygienic defects, season, temperature, or any meteorological conditions of which we are cognizant. They are probably due to causes tending to depress the general health of the population, and so to predispose it to the action of the poison. For nearly two centuries it has been a common observation that epidemics of small-pox have co-existed with epidemics of other contagious diseases. The gradual accumulation also in a district, of unprotected persons, owing to the neglect of vaccination, will also predispose to the occurrence of an epidemic, after the introduction of the poison. In fact, to the neglect, or careless performance of vaccination, is

entirely due the occurrence of epidemics of small-pox at the present day.

2. *Scarlet Fever.*—The early history of scarlet fever is obscure, for the disease was long confounded with measles and small-pox, but it is generally supposed that, like small-pox, it came originally from Africa, and was imported into Europe by the Saracens. It has been known to prevail in Britain for the last two centuries; but although it is only of late years, from the reports of the Registrar-General, that we have been able to form an accurate idea of the extent of its prevalence, there can be no doubt that it has increased greatly during the present century, and that it now occupies that pre-eminence among the causes of mortality in childhood which was formerly held by small-pox. During twenty-four years (1838 to 1861 inclusive) 375,009 of the population of England and Wales, and 53,663 of the inhabitants of London, died of scarlet fever, or about 1 in every 24 deaths that occurred in England during the period in question, was due to this disease. The mortality from scarlet fever, in fact, exceeds the mortality from small-pox and measles taken together. Scarlet fever is known to prevail over the whole of the continents of Europe and America, but it is nowhere so common as in Britain. In France it is a rarer disease than either measles or small-pox. In India it is said never to occur. In most instances it is not difficult to trace the occurrence of scarlet fever to contagion; and from the remarkable indestructibility of the poison and its tendency to adhere to clothes, furniture, and even to the walls of houses, there can be little doubt that the disease has a similar origin in many instances, where the mode of transmission of the poison cannot be traced. How the poison first originated is yet a mystery; but there is some probability in the view, which has many able advocates, that it originated in horses or cattle, and by them was communicated to man. If this be so, it is reasonable to hope that investigations as to the occurrence of the disease in the lower animals may lead to a discovery productive of as great benefits to the human race as vaccination. At intervals of a few years, scarlet fever spreads as an epidemic; but its ordinary prevalence in this country is greater than is generally imagined. The causes of these epidemic outbursts are unknown. Many circumscribed outbreaks can no doubt be traced to the importation of the poison into a population of persons unprotected by a previous attack; but why the poison should be introduced into numerous localities at one time, and not at others, is difficult to determine. It is tolerably certain, however, that at all times the prevalence of the disease is independent of overcrowding, bad drainage, or of any appreciable hygienic or meteorological conditions.

3. *Measles* was long confounded with scarlet fever, and, like it, is supposed to have been originally imported from the East. During twenty-four years (1838—1861) this disease destroyed 31,595 of the population of London, and 181,868 persons in England and Wales. It is known to occur in all parts of the world, and is highly contagious. There is no evidence that any hygienic defects or meteorological conditions can generate the poison of measles. Hildenbrand, a great authority, thought it might arise where numbers of men and cattle were confined together in close unventilated buildings; and in later times American and Irish physicians have described a disease corresponding in every respect with measles, which appeared to arise from sleeping on old musty straw, or from the inoculation of the fungi of wheat-straw. Measles in England is much less of an epidemic disease than either small-pox or scarlet fever. The number of deaths which it causes in years when it is most prevalent is rarely much more than double what it causes in years when it is least prevalent. Although often most fatal in winter, there is no proof that its prevalence is influenced by season.

4. *Typhus Fever* has been well known for upwards of three centuries, and there are grounds for believing that from remote ages it has prevailed in most parts of the world under favourable conditions. It is impossible to estimate the precise extent of its prevalence, inasmuch as many other diseases are included under the designation "typhus" in the reports of the Registrar-General; but it is the acknowledged scourge of the poor inhabitants of our large towns. There is no evidence that typhus, such as we see it in this country, has as yet been observed in Australia, New Zealand, Asia, Africa, or the tropical parts of America. Even in Britain it is confined, for the most part, to the large towns, and to the poorest and most densely crowded parts of them. It is a disease almost unknown among the better classes, except in the case of clergymen and doctors who visit the infected poor. It is undoubtedly contagious; but in a spacious dwelling with a free ventilation it almost ceases to be so. There is also ample evidence that the poison may be generated *de novo;* and the circumstances under which this occurs are overcrowding, with defective ventilation and destitution. Hence it is that the disease was formerly so apt to show itself in prisons and ships, and that, even at the present day, it is so common an attendant on warfare and so prevalent in the wretched hovels of the poor. This was the disease that before the days of Howard was never absent from our prisons and hospitals, and that decimated the armies of the first Napoleon and of the allies in the Crimea. "If," says an

able writer on fever in the last century, "any person will take the trouble to stand in the sun, and look at his own shadow on a white plastered wall, he will easily perceive that his whole body is a smoking dunghill, with a vapour exhaling from every part of it. This vapour is subtle, acrid, and offensive to the smell; if retained in the body, it becomes morbid; but if re-absorbed, highly deleterious. If a number of persons, therefore, are long confined in any close place not properly ventilated, so as to inspire and swallow with their spittle the vapours of each other, they must soon feel its bad effects. Bad provisions and gloomy thoughts will add to their misery, and soon breed the *seminium* of a pestilential fever, dangerous not only to themselves, but also to every person who visits them or even communicates with them at second-hand. Hence it is so frequently bred in gaols, hospitals, ships, camps, and besieged towns. A *seminium* once produced is easily spread by contagion." But if overcrowding produce typhus, why is it that the disease prevails in the epidemic form, and then in a great measure disappears? The explanation is in this way. All the great epidemics of typhus have occurred during seasons of famine or of unusual destitution. One of the most common consequences of general destitution is the congregation of several families in one house, in consequence of their inability to pay their rents; and of the concentration in the large towns of many of the inhabitants of country districts. Famine predisposes to typhus by weakening the constitution; and it also tends to produce it, in so far as it causes an unusual degree of overcrowding. It has been the custom with many writers to refer epidemics of typhus to some subtle "epidemic influence;" and thus, where a failure of the crops has been followed by typhus, both of these disasters have been ascribed to a common atmospheric cause. But of such atmospheric influences capable of producing typhus we know nothing; their very existence is doubtful, and the employment of the term has too often had the effect of cloaking human ignorance, or of stifling the search after truth. If typhus be due to any "epidemic influence," why does this influence select large towns and spare the country districts? why does it fall upon large towns in exact proportion to the degree of privation and overcrowding among the poor? in large towns, why does it infect the crowded dwellings of the poor and spare the habitations of the rich? and why did the varying prevalence of typhus among the French and English troops in the Crimea correspond exactly to the varying degree of overcrowding in either army? Moreover, famine *artificially* induced by warfare, by commercial failures, by strikes, or by any cause that throws large bodies of men out of employment, is equally efficacious in originating epidemics of typhus, as famine from failure of the crops.

5. *Relapsing Fever* is so called from the fact that after a week's illness there is an interval of good health for a week, followed by a second attack. It is contagious, and is epidemic in a stricter sense than even typhus. Although sometimes more prevalent in this country than any other fever, it may disappear for so many years, that on its return it has more than once been thought to be a new malady. For upwards of ten years not a case of it has been observed in Britain, but it has constituted the chief component of many of the greatest epidemics of fever which have devastated this country and Ireland, and it was one of the diseases composing the "Russian Plague," which in the spring of the present year caused such unnecessary alarm in this country. It usually prevails in the epidemic form in conjunction with typhus, and it is connected in its origin more directly with protracted starvation and the use of unwholesome food than even the latter disease. Hence, in this country it is familiarly known as "Famine Fever," and in Germany as "*Hungerpest.*"

6. *Oriental Plague* is still met with in Egypt and in other Eastern countries; but, in the Middle Ages it frequently overran the whole of Europe and invaded England, and from the extent of its ravages it was known as the "*Black Death,*" and the "*Great Mortality.*" The Great Plague of London of 1665 is a familiar fact in history. Since then the disease has not been met with in this country. But British typhus is merely a modified form of Oriental plague, or, in other words, plague is merely typhus complicated with numerous abscesses beneath the skin. Cases of typhus are occasionally met with in this country, corresponding in every respect with true plague. Both diseases appear under similar circumstances, but those which generate plague are of a more aggravated character than those which suffice to produce typhus. The disappearance of plague from London, notwithstanding our vastly increased communications with Egypt, has been chiefly due to the better construction of our dwellings since the "Great Fire" of 1666. "It is probable," says an able writer on the plague, "that if this country has been so long forsaken by the plague as almost to have forgotten, or at least to be unwilling to own its natural offspring, it has been because the parent has been disgusted with the circumstances under which that hateful birth was brought to light, has removed the filth from her doors in which it was matured, and has adopted a system of cleanliness fatal to its nourishment at home. But if ever this favoured country, now grown wise

by experience, should relapse into former errors, and recur to her odious habits, as in past ages, it is not to be doubted that a mutual recognition will take place, and she will again be visited by her abandoned child, who has been wandering a fugitive among kindred associates, sometimes in the mud cots of Egypt, sometimes in the crowded tents of Barbary, and sometimes in the filthy kaisarias of Aleppo."

7. *Yellow Fever* is a contagious fever with a limited geographical range. Its geographical limits, as regards the New World, are from about 43° N. lat. to 35° S. lat.; and in the Old World from 44° N. to 8° or 9° S. lat. It is a common disease on board our ships stationed in the West Indies and off the west coast of Africa. As in the case of typhus, overcrowded and defective ventilation are the main causes which favour its origin and propagation, and, indeed, it is still a subject for investigation whether yellow fever may not be typhus modified by climate and other circumstances. One of the most recent and best authorities* on the disease thus writes:—"Overcrowding in the between-decks of steamships seems to be the principal cause of the extreme fatality of the disease in the navy. What in this respect is true of typhus may with equal force be said of yellow fever. There is no such powerful adjuvant to the virulence of the poison, and to its power of propagation, as an unrenewed atmosphere, loaded with human exhalations."

8. *Diarrhœa* is always more or less prevalent in this country during the summer and autumn. There is no reason to believe that epidemic diarrhœa is contagious, but there is a direct ratio between its prevalence and the temperature of the atmosphere and the absence of ozone. As the temperature rises, the cases increase in number, and as it falls they diminish, and the disease is always most prevalent in very hot seasons. Diarrhœa may be due to many different causes, but its epidemic prevalence in autumn is chiefly accounted for by the absorption into the system of the products of putrefaction of organic matter, either in the form of gaseous effluvia or through the vehicle of drinking-water.

9. *Typhoid or Enteric Fever* is very commonly confounded with typhus, with which, however, so far as its origin is concerned, it has nothing in common. It is not, like typhus, confined to the poor, but it prevails among rich and poor alike; and, indeed, there are some reasons for believing that the rich and well-fed are more prone to be attacked by it than the destitute. It is the fever by which Count Cavour, several members of the royal family of Portugal, and our own Prince

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* Dr. Gavin Milroy, President of the Epidemiological Society.

Consort, came to their untimely end. It differs also from typhus in the circumstance that its origin and propagation are quite independent of overcrowding with defective ventilation, and are so intimately connected with bad drainage, that by some physicians the fever is now designated *pythogenic*, or fever born of putridity. It is asserted by some writers that the poison of enteric fever is never generated in obstructed drains, but that the drains are merely the vehicle of transmission of the poison from an infected person. But if this were so, enteric fever must needs be a most contagious disease, whereas all experience goes to show that it rarely spreads, even under the most favourable circumstances. The disease, in fact, is so slightly contagious that many excellent observers have doubted if it be so at all. It is probable that certain meteorological conditions, such as a high temperature, a defective supply of ozone, or a peculiar electrical state, may be necessary for the production of the poison of enteric fever; and thus, nuisances which are offensive to the senses may exist for a long time without producing the disease. The necessity of a high temperature is undoubted, and is itself a strong argument against the view which makes drains merely the vehicle of transmission of the poison. It is well known that enteric fever, like ordinary diarrhœa, becomes epidemic in this country every autumn, and almost disappears in spring, while the autumnal epidemics are always greatest in seasons remarkable for their high temperature. Enteric fever is much later in commencing and in attaining the acme of its autumnal prevalence than diarrhœa, showing that a longer duration of hot weather is necessary for its production; but, when once produced, a more protracted duration of cold weather seems necessary for its destruction.

10. *Cholera.*—Epidemic cholera is generally described as having originated at Jessore, in the delta of the Ganges, in the year 1817, and as having spread thence over Hindustan, and ultimately to Europe. Since 1817, Europe has been visited by three great epidemics of cholera; viz., in 1832, in 1848-9, and in 1854; and at the present moment, it is threatened with a fourth. During the past autumn the disease has appeared at Ancona and Marseilles, and at many other places in the basin of the Mediterranean. In England and Wales, cholera destroyed 53,273 lives in 1849, and 20,097 in 1854. Although the great epidemics of cholera have appeared to take their origin in India and gradually to have spread to Europe, following often the lines of human intercourse, the evidence in favour of its being a very contagious malady is small. The attendants on the sick are rarely attacked; and, on the other hand, the disease has often appeared in isolated localities,

where it was impossible to believe that it was imported. It is a remarkable circumstance also, that some of the greatest epidemics which have occurred in India, as that of 1861, have shown no tendency to travel to Europe, notwithstanding the constant communication that exists. Even on the supposition, then, that cholera is of necessity imported from India, there must be something as yet unknown to us that favours its transmission at one time, and not at another. But it is very doubtful if the disease is imported in the manner generally believed. Unequivocal cases of "Asiatic cholera" have been met with almost every year in the intervals of the great epidemics; and, as Dr. Farr has observed, it is highly probable that true cholera has always existed in England. The researches of the late Dr. Snow render it highly probable that the disease often arises from drinking water impregnated with the *fermenting* excreta of persons suffering from the disease; and if this be so, from what we know of other diseases, it is not unreasonable to infer, that, in certain conditions of the atmosphere, the poison of cholera may be generated during the fermentation of the excreta of healthy persons. It can readily be conceived how the necessary meteorological conditions might originate in the East and gradually extend to this country, and thus lead to the supposition that the disease has been propagated by a specific poison.

11. *Dysentery.*—Epidemics of dysentery are confined to tropical countries, and need not occupy much attention at present. Atmospheric states which unduly or suddenly depress the temperature of the surface of the body are the most common exciting causes. They are most apt to take effect in the case of persons whose constitutions have been weakened by long exposure to extreme heat, to malaria, or to other debilitating causes. There is no positive evidence that dysentery is contagious.

12. *Agues and Remittent Fevers* are now but little known, and scarcely ever fatal, in this country. Many years ago, however, they were among the most common and the most fatal diseases of Britain. James I. and Oliver Cromwell both died of ague in London. The disappearance of ague has been in direct relation to the drainage and cultivation of the soil, and this remark applies not only to England, but to all parts of the globe. The fens of Lincolnshire and Cambridge are almost the only parts of England where agues are now known; but in many countries, and particularly in the tropics where the vegetation is very rank, they are still the most common of all diseases. Agues are not contagious, but result from the *malaria* given off during the evaporation from marshy uncultivated land. These malaria may be wafted to a con-

siderable distance by the wind. A high temperature and rank vegetation seem to favour their production and to increase their virulence.

13. *Influenza.*—Severe and wide-spread epidemics of influenza have been observed in various parts of the world from time immemorial. In the present century the disease has been epidemic in this country in 1803, 1831, 1833, 1837, and 1847. On each occasion, it has been particularly fatal in aged and debilitated persons, and it has often been followed by an increased prevalence of other epidemic diseases. Influenza is not contagious, but depends on some unknown condition of the atmosphere. Sudden alternations of temperature have been thought to favour its origin.

14. *The Sweating Sickness.*—This remarkable and very fatal disease is happily now unknown in this country; but in the Middle Ages many great epidemics of it were observed, and nowhere were they more common than in England. Many of the epidemics were in fact confined to England. There are records of five distinct visitations of the disease during the fifteenth and sixteenth centuries; viz., in 1485, 1506, 1517, 1529, and 1551. The disease attacked all classes alike, and was often fatal within a few hours. From the accounts handed down to us, it is impossible to form any accurate idea as to the causes of its origin and extension; but the prevalent opinion at the time seems to have been that it was due in the first instance to atmospheric influences.

15. *The Dancing Mania.*—The present brief summary of the principal epidemic diseases would not be complete, without alluding to the dancing mania of the fourteenth and fifteenth centuries. The effects of the *Black Death* of the fourteenth century had not yet subsided, and the graves of millions of its victims were scarcely closed, when, we are told by Hecker, a strange delusion arose in Germany, which took possession of the minds of men, and, in spite of the divinity of our nature, hurried away body and soul into the magic circle of hellish superstition. It was a convulsion which in the most extraordinary manner infuriated the human frame, and excited the astonishment of contemporaries for more than two centuries, since which time it has never reappeared. It was called the dance of St. John or of St. Vitus, on account of the Bacchantic leaps by which it was characterized, and which gave to those affected, whilst performing their wild dance, and screaming and foaming with fury, all the appearance of persons possessed. It was propagated by the sight of the sufferers, like a demoniacal epidemic, over the whole of Germany and the neighbouring countries. While dancing, the infected persons were insensible to external impressions, but were haunted by

visions, their fancies conjuring up spirits, whose names they shrieked out. Some asserted that they felt as if immersed in a stream of blood, which obliged them to leap so high; while others saw the heavens open, and the Saviour enthroned with the Virgin Mary. The accounts of the dancing mania collected by Hecker at first sight seem almost fabulous, but cease to be so when we recollect the practices of certain modern religious sects and the accounts of the so-called "revivals" in the middle of the nineteenth century.

From the preceding summary, it is obvious that epidemic diseases vary greatly in their nature.

1. First we have diseases, such as small-pox, scarlet fever, and measles, which at the present day can only be traced to contagion, and some of which probably took their origin in the lower animals.

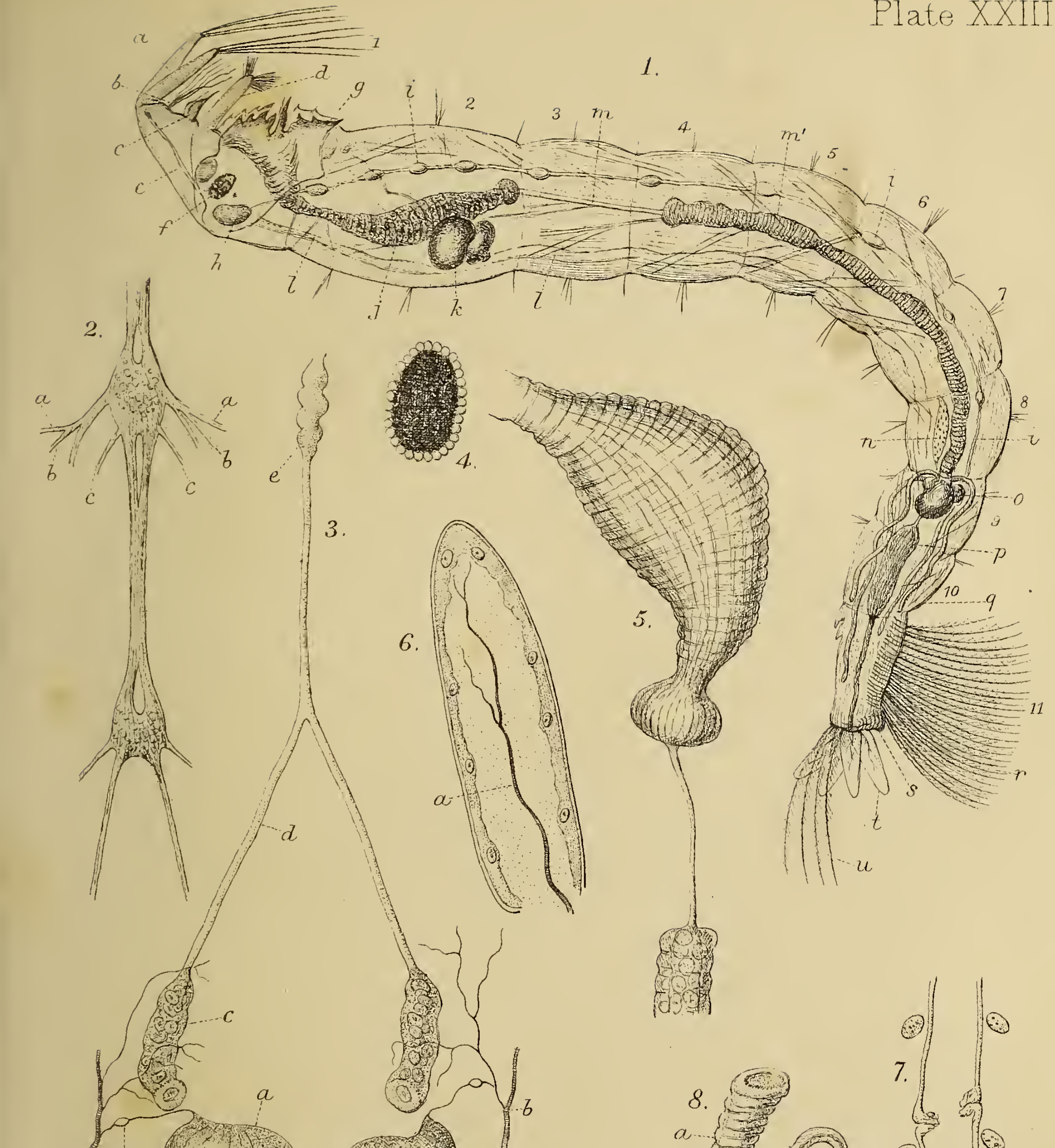
2. There are diseases, such as typhus, relapsing fever, enteric fever, and probably also plague, yellow fever, and cholera, which are capable of propagation by contagion in varying degrees, but which may also originate from the neglect of sanitary laws, aided by certain meteorological conditions.

3. A third class, including agues, remittent fevers, and diarrhœa, are not at all contagious, but arise from malarious exhalations.

4. A fourth class, including influenza, dysentery, and, perhaps, the sweating sickness, are also not contagious, and arise from certain atmospheric conditions.

5. The dancing mania differed from all other epidemic diseases in being purely mental, and in depending on the mere sight of a disagreeable nervous malady.

Plate XXIII.



E. Ray Lankester, del. T. West, sc.

W. West, imp.

The Anatomy of the larva of Corethra plumicornis.

BRITISH MUSEUM
NAT. HISTORY

ON THE MICROSCOPIC ANATOMY OF AN INSECT LARVA.—*CORETHRA PLUMICORNIS.*

BY E. RAY LANKESTER.

AMONG the commonest objects of interest to be met with during early summer in the ponds and pools near the metropolis, is a perfectly transparent crystalline little creature, having much the appearance of a small glass worm. It is the larva of a dipterous insect, the *Corethra plumicornis,* and forms a most beautiful and instructive object for examination with the microscope. The larva is only about two-thirds of an inch long, and is easily obtained by drawing a handful of weed from the pond which it inhabits, and placing the mass in a vessel of water, when the Corethra larvæ will float out and make themselves apparent by their curious jerking movements, without which indeed they might escape observation, so excessively transparent and glass-like are they. Many years ago, before microscopes were what they are now, Mr. Pritchard and Dr. Goring gave a rough figure and a description of this little creature in their "Microscopic Illustrations," but both are so exceedingly imperfect and erroneous that they will not be found of any value or use at the present time. Abroad these larvæ have been a little more carefully studied, but no general description or illustration of their anatomy has been published. Dr. Franz Leydig in 1854 communicated a very interesting paper on their histology to Kölliker and Siebold's Zeitschrift, in which the structure of the nervous system was figured, but no drawings given of other parts of the animal's organization. A description, therefore, and drawings of its anatomy, which is exceedingly instructive, cannot but be of interest and value to the readers of the POPULAR SCIENCE REVIEW.

The Corethra larva (fig. 1) is composed of eleven segments, which are not very distinctly marked, but still are recognizable. The first segment forms the head, and has very remarkable appendages in the form of prehensile and masticatory organs, which will presently be described; the last is furnished with four terminal plates (fig. 1, *r*), and a terminal (*n*) and lateral (*t*) plume of feather-like hairs. The membrane which forms the wall of the body is very delicate and quite transparent, it, however, gives support to four hairs in each segment of very beautiful structure (fig. 10). This hyaline skin is shed several times in the course of the larva's existence until it becomes a pupa. It is underlain by a tunic of granular tissue containing cells, which are very well seen in one of the terminal plates (fig. 6). The parts about the head are not soft like the rest of the body, but have a yellowish appearance, and are chitinous—there are also two chitinous hook-like bodies and twelve small serrated plates at the other extremity of the body (fig. 1, *s*).

Organs of prehension and mastication.—The anterior portion of the body is terminated by two remarkable-looking arms (fig. 1, *a*). Each consists of two parts, a stem and four long terminal bristles; the base of the stem is hollowed out and inserted into the head, where it is connected with a long muscle, which can easily be seen running beneath the transparent skin (fig. 1, *e*). These organs move by very sharp jerks, and seem to aid locomotion as well as the capture of prey. Succeeding these arm-like bodies is a group of ten long and thick hairs, which are all connected with a muscle at their base (fig. 1, *b*). Next to these come two very curious saw-like little bodies (fig. 1, *c*; fig. 11), which appear to be quite immovable. Behind these, in the central line, is a projecting cylindrical body, which is moved either backwards or forwards by two muscles which may be very readily observed. The top of this organ is covered by two groups of hairs, which are arranged so as to point towards the mouth. Then follows the mouth, which is armed on either side by two very powerful jaws, whose form and arrangement will be best seen in the figure (fig. 1, *g*). The chitinous material of which the jaws are formed spreads over a large portion of the head, and forms a protecting shield to some delicate organs placed beneath it. On the inner surface of each jaw is a group of twelve hard bristles, which are closely packed together, and have one edge very finely serrated. They doubtless act like the jaws in crushing and breaking up the smaller animalcules (*entomostraca*, &c.) on which the Corethra larva feeds.*

Organs of digestion.—The pharynx, commencing from the mouth, is very muscular, and expands in the second segment of the body into a large sac (fig. 1, *j*) (fig. 5); it terminates in the second segment in a rounded muscular body, which is of a bright yellow colour. The muscular fibres in the walls of this little gizzard are arranged horizontally and laterally also, and appear to give it very great power. Extending from this

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* These bodies may be conveniently denominated, successively, Tarsognaths, Trichognaths, Pristognaths, Mesognaths, Platygnaths, and Charactognaths.

body, through the whole of the third and a part of the fourth segments, is a very narrow colourless œsophagus (fig. 1, *m*); its delicate walls and small calibre form a striking contrast to the large pharynx and stomach on either side. The stomach commences in the second half of the fourth segment, and continues to the end of the eighth. Its walls are very muscular, and are composed of three tunics and external serous or structureless membrane, a middle muscular and an internal glandular layer. The glandular portion is by far the most highly developed, and the cells of which it is composed, containing very distinct nuclei, and of a dull yellow colour, are very easily seen. The glandular layer most probably secretes some fluid to aid the digestion of animal matters, similar to the gastric juice of higher animals. At the point where the stomach terminates, at the beginning of the ninth segment, five different continuations of it are given off (fig. 8). The central one is the intestine, the other four being glandular cæcal appendages. Two of these cæca terminate in the tenth segment, and two are continued into the last, or eleventh. Leydig in his paper only mentions two of these bodies, and does not figure them at all. They are tubular in form, their walls being very thick, and containing very numerous cells of large size and granular matter. What their function may be is not easy to conjecture.* The intestine through the ninth segment is of very small dimensions, but highly elastic, and resembles the œsophagus; in the tenth segment it expands into a pear-shaped organ, which has very muscular walls, and seems to form a sort of reservoir for the fæcal matters. The pear-shaped sac extends only through the tenth segment; in the eleventh it is succeeded by a straight rectum, which communicates with the exterior by an aperture in the centre of the four terminal plates, of which we have already spoken. The remarkable form of alimentary canal just described is adapted to the requirements of a carnivorous animal. The Corethra larva is a great devourer of entomostraca, particularly the *Daphnia pulex*, which it demolishes with astonishing rapidity. Its predatory habits were noted by Mr. Brightwell, of Norwich, in the *Zoological Journal* of 1833, and a very bad figure of the larva given. Réaumur also gives a poor sketch of the little creature in his work on insects; but neither the one nor the other gives any idea of the details of its form or structure.

Organs of respiration.—When the Corethra larva is swimming about in the water, besides the two black eye-spots

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* These glandular cæca seem very similar to the pyriform bodies described by Mr. McAlister from the nematoid parasite of Testudo græca (A. N. H., July, 1865).

situated in the head, another pair of little black bodies is seen not far from them (fig. 1, *k*), and a third pair by the tail (fig. 1, *o*). These two pairs of black-looking bodies, when viewed under the microscope, are seen to be situated, the one in the second segment, the other in the ninth. In structure they are found to be delicate little bags, composed of an elastic, finely-striated membrane, and filled with air. They are connected with a very fine and delicate system of air-tubes or tracheæ, which, though not very abundant or largely developed, ramify through various parts of the body, being distributed principally to the nervous ganglia and digestive organs. The little black-looking sacs are in fact air-bags—tracheæ vesicles—and, with the tubes connected with them, represent the extensive tracheary system, into which they afterwards become developed in the perfect insect. In fig. 3, *a*, *b*, the anterior pair of the air sacs, with its connected air-tubes, is seen. In shape they are somewhat reniform; the exterior point of each is slightly produced and drawn out into a fine and delicate tube, which becomes slightly enlarged (*b*), and then joins the main lateral trunks of the tracheary system. The surface of both pairs of air sacs is more or less covered by dark hexagonal pigment cells of considerable size, and deep brown in colour. The function of these pigment cells is not at all obvious. It is somewhat difficult to trace the course of the air tubes through the body. They send out branches in various directions, particularly supplying the large cephalic ganglion and other nervous centres. Each of the terminal plates (fig. 1, *r*) is penetrated by a branch from the tracheary system (fig. 6, *a*), and the array of lateral hairs, which are hollow as well as the terminal plume (fig. 1, *t*, *u*) are connected with it. The structure of one of the hairs of the lateral plume is seen in fig. 9.

Salivary organs.—It is supposed that the organs (*c*, *d*, *e*) seen in fig. 3, in connection with the air-sacs, are salivary organs. There are two elongated vesicles (*c*), which are composed of large nucleated cells; each gives off a tube, which unites with the other in the median line; the tube is continued to near the mouth, where it becomes considerably enlarged, and opens apparently into the pharynx near the mouth. The glandular part of these bodies, as seen in the figure, is copiously supplied with branches from the tracheary tubes.

Organs of circulation.—There are no blood-vessels in the Corethra larva, nor should we look for them, since in insects the circulation is effected by a simple dorsal vessel, or heart, and a series of sinuses from which it draws and to which it returns the nutritive fluid. The dorsal vessel is very beautifully seen in the little creature under description. It is situated above the intestine (fig. 1, *l*) (in our figure the larva is represented on its back, as it very frequently appears when swimming), and commences near the first in the second segment, and extends to the end of the tenth. Its walls are completely transparent and colourless, as is also the fluid which it contains; and it therefore requires a little focusing and a good object-glass to see it well. Near the commencement of each segment, if the contractions and dilatations of the heart be watched, a small lipped orifice on either side of the vessel will be seen to open and shut, the lips playing the part of valves; beneath each valve on either side is a large transparent cell (fig. 7); and again another pair of cells before the next valve is reached. These bodies appear to be nerve-cells, destined to control the movements of the heart. The number of contractions of any one part of the heart in a minute appears to be about twelve. The movements of the vessel can be easily watched, and the opening and closing of the valves, and the structure of the presiding ganglia, form most interesting objects for study.

Muscular system.—The muscles of the Corethra larva, like the other parts of its organization, are quite transparent, and readily admit of observation. Their striped structure is easily observed. Those connected with the moveable appendages of the head can readily be isolated and named; but with regard to the muscles of the other segments of the body, there appears to be a general repetition of form and arrangement. Oblique muscles pass from one segment to another, crossing and inter-crossing so as to constitute a mechanism whereby those rapid jerks and spasmodic actions may be produced, by means of which locomotion is effected. In the eleventh segment a long muscle is perceptible, by means of which the lateral plume is elevated or depressed, the bases of the hairs which form it being connected with this muscular band. The muscular fibre of the heart and alimentary canal is of the unstriped description, as in higher animals.

Nervous system.—The nervous system in this little larva consists of supra- and sub-intestinal portions. The supra-intestinal portion is placed in the first segment (fig. 1, *h*), behind the eye (*f*). It consists of two large ganglia, which send nerves to the eye and other parts of the head. A great number of minute tracheary tubes ramify on the surface of these ganglia. They are connected by two bands of nervous matter, with the first sub-intestinal ganglion, which is situated at the anterior end of the second segment, closely attached to the pharynx. This ganglion is oval in shape, and sends off no large branches but the two commissures; it is connected by a commissure of nervous matter with the second sub-intestinal ganglion, which again is succeeded by the third and fourth, making four in the second segment. A single ganglion, the fifth, exists in the third segment, the sixth in the fourth, and so on till the ninth segment, in which we have both the eleventh and twelfth situated. These two ganglia are seen in fig. 2. All the sub-intestinal ganglia but the first and last resemble the eleventh in their form and structure, and in the manner of the origin of the nervous twigs. Those of the second segment are, however, much larger than the others. The commissures which connect the several ganglia consist of two cords of nerve fibre, which for the greater part are fused together. No large branches are given off from the commissures, excepting between the first and second ganglia, where two large twigs arise, supplying apparently the muscles of the jaws. The distribution of the branches from an ordinary ganglion is as follows. The branches marked *a* (fig. 2), supply the more superficial muscles; those marked *b*, are distributed to the deep muscles; and those marked *c*, are connected with ganglionic enlargements at the bases of the little hairs (fig. 10) with which the surface of the body is supplied.

Organs of sense.—The only organ of special sense which the larva possesses is the eye. A pair of compound eyes and a rudimentary simple eye placed near it are situated one on either side (fig. 1, *f*), just below the cephalic ganglion (*h*), and near the mouth and jaws. The eye consists of a great number of minute lenses arranged in connection with a mass of pigment so as to affect the nerves connected with the cephalic ganglion. An enlarged view of one of the compound eyes is given in fig. 4. The rudimentary eye, noticed by Leydig in his paper, is merely a small mass of pigment placed by the side of the compound eye, and not provided, as far as we could ascertain, with anything like a lens.

Reproductive Organs.—In the eighth segment are two cellular bodies of an elongated elliptical shape. Dr. Leydig considered these as rudimentary reproductive organs, an opinion in which we are inclined to coincide (fig. 1, *n*).

We trust that the foregoing remarks on the anatomy of this pretty little creature may have proved of some value to the reader, and that they may assist him in working out on some future occasion the history of the larva of *Corethra plumicornis*.

EXPLANATION OF PLATE.

Fig. 1. Larva of *Corethra plumicornis* (natural size two-thirds of an inch).
- *a.* *Oar-like* appendages, or Tarsognaths.
- *b.* Labial bristles, or Trichognaths.

c. Saw-like organs, or Pristognaths.
d. Central prehensile organ, or Mesognath.
e. Muscle of Tarsognath.
f. Compound eye.
g. Toothed-plate-like jaws, or Platygnaths, covering the Charactognaths.
h. Cephalic ganglion, or brain.
i. Ventral chain of ganglia.
j. Muscular pharynx.
k. Anterior air-sacs, or trachea-bags.
l. Heart, or dorsal vessel.
m. Œsophagus.
m'. Stomach.
n. Rudimentary reproductive organs.
o. Posterior air-sacs.
p. Pyriform enlargement of the intestine.
q. Glandular appendages.
r. Lateral plume.
s. Serrated appendages.
t. Terminal plates.
u. Terminal plume.

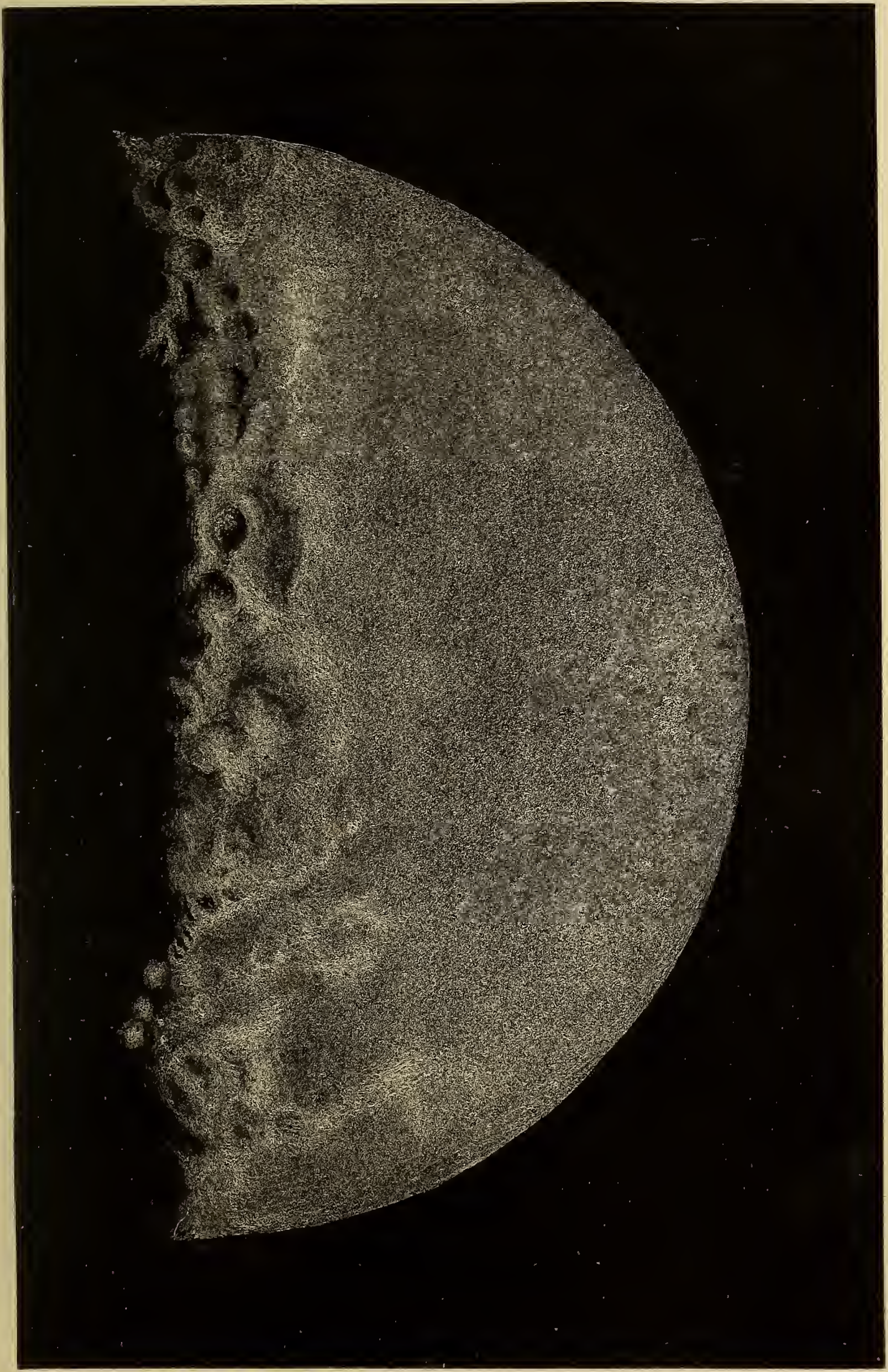
Fig. 2. The 11th and last ganglia of the ventral chain.
„ 3. The air-sacs (*a*), with attached tracheæ (*b*), and the supposed salivary organs (*c*, *d*, *e*).
„ 4. Compound eye of Corethra larva.
„ 5. Pharynx and œsophagus.
„ 6. Terminal plate, showing parietal cells and trachea.
„ 7. Part of the dorsal vessel, or heart, showing the valves and ganglia.
„ 8. Posterior portion of the alimentary canal, showing—
  a. Stomach.
  b. Intestine.
  c. Pyriform enlargement.
  d. The four glandular appendages.
„ 9. Part of one of the hairs forming the lateral plume.
„ 10. Hair from the surface of the 8th segment.
„ 11. One of the saw-like appendages from the mouth.

THE MOON.

BY JAMES BREEN, F.R.A.S.

FOLLOWING the example of Paracelsus, who, according to his own account, was able to hold conversations with the dead, Cardan informs us that he himself was gifted with the power of falling into an ecstasy whenever he chose, and of seeing whatever he pleased. Thus, for instance, he could see the sky radiant with stars at mid-day, and on one occasion he tells us he received a visit from an inhabitant of the moon. It is to be feared, however, that the scientific Munchausen did not receive much reliable information respecting our satellite from his unearthly guest; at least, our first knowledge of its constitution dates from the time of Galileo and the discovery of the telescope (1610), although the mountainous character of its surface was already suspected, from a rugged projection of the inner part of the crescent, which at one phase of the moon is apparent even to the naked eye.

If we follow the moon through a lunation, as the sun's light beats successively against the rugged shores of the broken part of the inner crescent, we see every variety of bold and bleak mountain scenery, and that, too, without the danger attendant on alpine ascents. It is true that, as with the other bodies of the system, we must in general remain satisfied with a bird's-eye view of its hills and peaks; for even at the circular edge of the moon, where we should see them best, they are so closely piled together that it is impossible to distinguish them separately, except when one of extraordinary height projects beyond its otherwise smooth edge. But we can see, from the gigantic shadows which the mountains cast, their rugged form and great height. Every hour changes the appearance of the broken edge; the outlying and isolated peak of some great mountain-chain becomes gradually larger, and is finally merged in the general luminous surface; great circular spaces, enclosed with rough and rocky walls many miles in diameter, become apparent, some with flat and perfectly smooth floors, variegated with streaks; others



From Photograph.

W West lith^r

View of the Moon

BRITISH MUSEUM
NATURAL HISTORY.

in which the flat floor is dotted with numerous pits or covered with broken fragments of rock. Occasionally a regularly-formed and unusually symmetrical circular formation makes its appearance; the exterior surface of the wall bristling with terraces rising gradually from the plane, the interior one much more steep, and instead of a flat floor, the inner space is concave or cup-shaped, with a solitary peak rising in the centre. Solitary peaks rise from the level plains and cast their long, narrow shadows athwart the smooth surface; their great height is seen from the distance between the summit, when first illuminated by the sunlight, and the illuminated continent. Vast planes of a dusky tint, which were long mistaken for seas, become visible, but it will be seen that they are not perfectly level, but covered with ripples, pits, and projections. Circular wells, in which there is no surrounding wall, dip below the plain, and are met with even in the interior of the circular mountains and on the tops of its walls. From some of the mountains great streams of a brilliant white radiate in all directions, and can be traced for hundreds of miles. We see, again, great fissures, almost perfectly straight and of great length, although very narrow, which appear like the cracks in moist clayey soil when dried by the sun. This heap of fissures, caverns, plains, bright radiations, "ring mountains" (whether cup-shaped or with flat floors), great chains of immense height, fearful Matterhorns, and solitary peaks, are scattered in the greatest disorder, and met with at every phase of the moon. There is no sign of life or motion—no clouds floating over the lunar surface, and the latter might be mistaken for the locality between Dan and Beersheba.

The so-called seas are of immense size, and indeed the only separate formations which can be seen with the naked eye, when they appear as dusky spots. They are mostly of a circular shape, and on this account are supposed to have some connection with the other annular formations of the moon. Twenty-one of those have been counted, which have received, among others, the fanciful appellations of the Seas of Clouds, Fertility, Sleep, Dreams, &c. The *Mare Serenitatis*, situated in the north-western part of the moon, is one of the largest, and is connected with the other great plains, the *Mare Tranquillitatis* and the *Mare Fœcunditatis*, the three being in nearly a straight line, and occupying a very considerable portion of the western part of the moon. It is calculated that the surface of the *Mare Serenitatis* is about the area of the British islands, and its diameter between four and five hundred miles. The *Oceanus Procellarum*, in the opposite quadrant, is that which is most apparent when the moon is full, covering as it does one-fourth part of its surface. Other great seas will be seen in the eastern and northern portions of the moon; the parts most free from them being the southern and south-eastern, which is thickly covered with annular mountains. But it is at once seen that these level plains are very different in respect to their darkness, and even in their colour. The *Mare Crisium,* situate near the western boundary of the moon, is very dark, and the *Mare Tranquillitatis* is almost equally so, whilst the *Mare Nubium,* lying between *Tycho* and *Copernicus,* is of a much lighter shade. In some of those seas the surfaces are very smooth, and in some parts almost perfectly polished; but others are very irregular, and covered with great isolated rocks, craters, and even mountain-chains. They are sometimes traversed by long veins or very extensive and level ridges, which ascend to the higher *plateau* by a very gradual slope. Perhaps the long flat plain which Mr. Key lately discovered at the circular contour of the moon may have been one of the unmapped seas which come into sight at certain periods. A similar appearance, on a much less extensive scale, was seen by Mr. Lassel, in May, 1864, but seems to have been flat land between two projecting mountains; the latter being very common at this part of the moon, which comprises the highest mountains, or those of Doerfel and Leibnitz. Both observations are very remarkable, and prove that the contour of the moon is far from being circular, and that great irregularities exist at certain times, according to the libration of our satellite.

Colour has been detected in those seas, but is very difficult to be perceived, and some eyes can only detect the ordinary grey or neutral tint of different intensities. The "*Mare Humorum*" is that in which this green tinge is considered strongest, although all the other seas partake of it more or less. It has been debated whether it is due to the presence of the vegetable or mineral kingdom in the moon; if in the former, it must, of course, be taken as a proof of the existence of an atmosphere. The "seas" are by no means the darkest parts of the moon. The floor of the mountains *Grimaldi* and *Riccioli,* at the east part of the moon, are considerably darker, as likewise the walled plain *Plato.* The latter, on account of its dark colour, was formerly denominated the *Lacus Niger,* although it is a perfect example of the type of annular mountains. Sir J. Herschel considers those vast plains or seas as of a decidedly alluvial character.

The "seas" are the only parts of the moon which can be seen by the naked eye, and that very imperfectly. With the telescope there comes into sight a much more remarkable view of its surface, and amidst the first objects which catch the eye are the remarkable mountainous circular formations. Their similarity to the great volcanoes of the earth, extinct or otherwise, has often been remarked. The maps of the environs of Naples, of Vesuvius, of the volcanoes of Auvergne and Teneriffe, present the same features. But those sink into insignificance when compared with the vast surface of the lunar volcanoes, and could scarcely be perceived if seen from the moon, and the whole of those known on the earth might be placed within one of the lunar annular mountains. They are different in other respects from the earthly volcanoes, as the bottoms of the craters on the moon's surface dip below the general surface. The central peak, which appears in many of those formations, is also reproduced in the volcanoes of the earth, and is so perfect and decided that it is astonishing to believe that Kepler could think for a moment that they were artificial formations excavated by the lunar inhabitants to shield themselves from the rays of the sun. The perfect annular mountains with a concave interior (to distinguish them from the walled plains and craters) are the most beautiful and regular of this group, and appear to have been the latest efforts of volcanic action. Among the most perfect specimens of this class are the well-known mountains *Tycho, Kepler,* and *Copernicus,* which are easily recognized by being surrounded by bright rays, and which will amply repay a minute examination. A mountain of this description, situated at the end of the chain of the *Apennines* and a little to the N.W. of *Copernicus,* is a perfect model of this class of objects. The outer walls, brilliantly white, as they rise from the level plain, are strikingly in contrast with the black shadows and grey seas which surround this volcano. Its interior walls are much more steep, but, like the outer, gradually descend by a series of steppes and terraces. In general the proper concave annular mountains are much inferior in size to the circular walled plains, and *Eratosthenes,* which is the name of the mountain just described, is only thirty-six miles in diameter. The walls are not of equal height all round, for whilst the eastern wall, as measured from the plain, is 7,500 feet high, the western one is only one-half that quantity. If measured from the interior, however, the eastern wall is 16,000 feet high, and that of the western about 10,000. The central peak or peaks are a crowd of rocky fragments, and do not rise to the height of the surrounding wall, which will be found to be the case with the other central peaks. The mountains *Copernicus* and *Tycho,* and the surrounding parts, with their bold and grand scenery, present a magnificent sight, and their terraces, peaks, and the shadows of their rugged tops, can be seen with even small telescopes. We lately viewed some of those annular mountains through a splendid telescope by Wray, armed with a power of 1,000 (one which would bring the moon within a distance of 240 miles of the earth), and the quantity of detail in and about them was quite marvellous, and to attempt to delineate those minutiæ would puzzle a pre-Raphaelite. With a powerful telescope we can detect the stratification of the rocks, as if successive layers of lava had been deposited at various times. In the mountain *Petavius* the shower of lava which formed the wall appears to have been arrested for a time and then to have burst out afresh, as we find here the phenomenon of a *double wall.* The height of those circular walls is sometimes enormous; that of *Newton* is surrounded by walls, some of the peaks of which rise to a height of nearly 24,000 feet. The great diameter of the volcanoes and the height of the walls may be explained by the small density of the matter which composes the moon, and also its weight in respect to that of the earth; for it would take eighty-eight moons to balance our earth; and whilst the lunar matter is only three times heavier than water, that of the earth is five and a half times its weight. Volcanic force, therefore, if it took place on the moon, would eject the lava and ashes to a far greater distance than on the earth, as a weight which would only be three ounces on the moon would be a pound on the earth, and the same force would throw a body six and a half times farther or higher on the former body. The great dimensions of these formations are best seen in the circular walled plains, the diameters of several of which range from 100 to 150 miles, though they may be as low as forty miles. Instead of a concave interior, as in the last-mentioned formation, we have here a flat floor, polished like marble in some cases, but in others it is exceedingly rough, with a number of rough blocks scattered confusedly over it. In the mountain *Gassendi* more than 100 such blocks are visible, whilst in others, as in the mountains *Plato* and *Archimedes,* the floor is perfectly smooth. In general, the circular-walled plains are not equally symmetrical with the concave formations; but the two last-named mountains are exceptions to this, the walls being very regular and rising in terraces. But in others the wall is of irregular height and shape, and in some cases even one-third is missing, though occasionally the gap is partly filled up with broken fragments. They are furnished frequently with the usual central peak, but in many cases that point is only denoted by a confused assemblage of rocks at the centre. In others we have great mountain-chains passing through them, and hollow craters and immense boulders scattered over their surface, giving an idea of their being subjected to great ravages after their formation. The floor is, as in the case of the walled concavities, lower than the surrounding parts, but Mr. Nasmyth has detected a circular walled plain, in which the floor is on the same level as the outer walls, as if the lava had bubbled up and filled the enclosure. It may be probable that this latter event may have taken place in the case of other smooth plains, as in the interior of *Plato* and *Archimedes*. In a few cases there appears to have been an upheaving at the centre, without any eruption; and this is very apparent in the mountain *Mersenne*, the floor of which is singularly convex. Schroeter has calculated that the cubic contents of the surrounding wall are nearly equal to that of the vacant space in the interior which dips below the exterior surface; and this applies to both annular concavities and the walled plains. In one small crater the difference between the volumes was only $\frac{1}{60}$th, in that of *Reinhold* the difference amounted to as much as $\frac{1}{4}$th, whilst in that of *Euler* the volume of the cavity is double that of the wall; but hundreds of other cavities have no wall at all. The peaks at the centre of the walled plains, as in those of the annular concavities, are never so high as the surrounding wall. They may be found of from four to five thousand feet high in *Maretus, Tycho, Petavius*, and *Theophilus*; but in those cases the outer wall is from three to four times that height. It is very singular to see chains of circular mountains running in almost straight lines for great distances. Thus, between *Hipparchus* and *Ptolemy* there is a row 36 degrees long, and there are two similar rows, one 60 degrees east and the other 60 degrees west of the above. The term "circular" is sometimes very inapplicable, as the mountain *Egede* is almost square, and *Descartes* is 37 miles long and only two in breadth. We now come to the smallest of these circular formations, viz., those simple depressions in the soil called *craters*, and which may be considered the most numerous of all. They occur everywhere—on the summits of the highest mountain-chains, in the most depressed portions of the concavities and walled plains; they are plentiful in the seas, and even can be seen, like parasites, attached to each other. Yet the smallest is almost equal to Etna, which is the greatest volcano on the earth. As in the case of the walled plains, they run together, when a sort of a door joins them together. As an example of this, we may take the part between *Eratosthenes* and *Copernicus*, the landscape about *Sasserides* and *Orontius*, the parts surrounding *Capella* and *Censorinus*, in the wall and the plain of *Albategnius*. On the north-west of *Ptolemy* there are six small craters, each of from 4,000 to 6,000 feet in diameter, which run together in a straight line, and which, as Maedler observes, present a charming appearance. Sometimes those pigmy caves—small at least in comparison with the other circular formations—have a small peak at the centre. That they are volcanoes can scarcely be doubted, and perhaps the expiring efforts of the volcanic force, as all the older formations are thickly covered with them. The "mountain-chains" are those which show the least approach to volcanoes, and bear the greatest resemblance to the great chains on the earth; and were it not for the appearance of a crater occasionally, they might be considered as belonging to the same terrestrial groups after which they are named; viz., the Alps, the Apennines, or Carpathian hills. They are mostly situated in the northern part of the moon, and are very white and bright. So high and extensive are the *Apennines* that this chain can be seen with the naked eye, when the moon is about half-full, and when it appears to be bulging into the dark space. The chain of the *Alps* is remarkable for a deep pass, which almost cuts it in two, and bristles with peaks and mountains.

Among the latest formations on the moon, Maedler reckons the long straight lines appearing when the moon is full, like pieces of thin white thread stretched over its surface, but at the other phases seeming quite black. There can be no doubt but that they are fissures, and it has been noticed that they occasionally pass through a succession of craters, as if some force acting underneath had split open the ground between the latter. They are between ten and a hundred and fifty miles long, and not more than five thousand feet broad; but their depth is unknown, although the writer would judge, from the appearance which one presented, when viewed under favourable circumstances, at the broken edge of the moon, that it was fully equal to its breadth. They are best seen in the "seas," but are also to be met with in the interior of the circular mountains, and it sometimes happens that the fissure passes through the walls. They are generally quite straight, but a few may be seen which are more or less curved, and their edges are slightly raised. They are most favourably observed in the *Sinus Medii*, in the neighbourhood of the mountains *Hyginus* and *Triesnecker*, where they appear like the branches of a river, which, indeed, some have conjectured them to be, although now divested of water.* Far more extensive and distinct than those are the vast and bright radiating streams, from *Tycho, Kepler, Copernicus,* and *Aristarchus,* which are best seen when the moon is full. The first of these has the most extensive streams, passing as they do to an average distance of four or five hundred miles over mountains, craters, and plains; but the latter are the brightest, and the mountain itself the most brilliant part of the lunar disc. Those round *Olbers* and *Byrginus* are less favourably seen. It can scarcely be imagined that they are streams of lava proceeding from the central mountain, for one of those passing from *Tycho* can be traced to a distance of nearly two thousand miles, and the more natural idea would appear to be that they were immense fissures caused by the eruption of the central mountain, through which the lava oozed. It has been proved that they do not rise above the surface, and their breadth ranges from two to twenty miles.

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* The terrestrial phenomena of the dykes of *Monte Somma*, in Vesuvius, may be of the same nature, in the same manner as one of the mountains near Clermont may be compared to the annular mountains, or the group round the great volcano of Jorullo, as given by Humboldt to the surface of the southern hemisphere of the moon.

It curiously enough happens that we were acquainted with the height of the lunar mountains before those on our own earth, or before the barometer was invented wherewith to measure them. Galileo estimated the height of some of the mountains to be nearly 29,000 feet high, and in recent times it has been found from actual measurement that one named *Doerfel,* at the southern part of the moon, is nearly 25,000 feet high. Upwards of twenty are higher than Mont Blanc. The highest peak on the earth is 28,180 feet; but if we compare the size of the earth and moon, we shall find that the proportion of the diameter of the latter to the height of its most elevated mountain is as 1 to 454, whilst the same ratio on the earth is as 1 to 1,481. Some of the highest of the mountains on the moon, as those of *Newton* and *Tycho,* are of the circular type.

The infinite variety of the scenery on the lunar surface can scarcely be described, and must be seen in order to be appreciated. It fortunately happens, however, that a telescope of moderate dimensions suffices to show the most striking features, although the higher the power made use of, the more detail is brought to view. The engraving accompanying this is copied from a photograph taken by the writer with the great telescope at the Cambridge Observatory, and may serve to give an idea of its rocky surface.

The existence of a lunar atmosphere is a *quæstio vexata* even at the present day, though it has been satisfactorily proved that if one does exist it must be of extreme tenuity. It may be granted that when volcanoes and fire were in full action on its surface, the moon was surrounded by air; at the present day, however, there is no sign of its existence. This has repeatedly been proved by the occultations of stars, which, taking the measured diameter of the moon only into account, are hid exactly the time they should be. If there was an atmosphere round the moon, the time during which the star is out of sight would be shorter, as the ray of light proceeding from the star would be bent from behind the moon's disc, and we should see the star attached to the moon's edge after it has really disappeared, as we see the sun and other objects above the horizon when they have set. If the distance between two stars at a short distance from each other, and which were about to be occulted, were repeatedly observed shortly before the time of occultation, it would be found, as Arago suggests, that if a lunar atmosphere did exist, the distance of the stars would go on gradually increasing. We do not know whether this last method, by which any error which may exist in the measurement of the moon's diameter is got rid of, has ever been tried, but the first has been repeatedly calculated, and it has been found that the density of the lunar atmosphere is less than that given by the best air-pumps. Sir J. Herschel, however, thinks that from the figure of the moon being elongated towards the earth, the opposite and larger hemisphere may be provided with a lake of water and a stationary volume of air.

In respect to changes on the moon's surface, it must be admitted that our knowledge is still in a very imperfect state. Considering that an object may appear to change its form or become visible or invisible, according to the manner in which the sun's light falls upon it, it is certain that even with the same instrument and observer, mistakes may occur on this point. Though Schroeter had very keen sight and powerful telescopes, yet Olbers was able to detect two small craters which had escaped his attention, and which he was not able to see until he had repeatedly tried. Even in the magnificent map of Beer and Maedler, which took so many years of continuous and persevering labour to complete (Jan. 1830 to Oct. 1836), there are numerous omissions; as for instance, the numerous rills which are seen in the interior of the mountain *Gassendi*. We are, however, now promised a chart which will be the most magnificent yet projected, and it is to be hoped that the design will be carried out in all its integrity. We allude to the map spoken of at the present meeting of the British Association, where the survey of a small part of its surface will be apportioned to different observers who shall direct all their care and energy to the most minute particulars of its surface; and it is to be hoped that the project may be more successful than a similar one started nearly twelve years since by the same learned society. The writer of this article then made several sketches and measurements of *Plato* and the lunar *Alps*, with the twenty-foot refractor at Cambridge; but it was found to interfere too much with the ordinary work of the Observatory to be continued. Enough, however, was seen to prove the omission of several details in the best maps. We may venture to say that the immense labour of Argelander, in his maps of the stars, extending to the faintest classes, is scarcely so difficult as in portraying the caves, craters, mountain-ridges, and stratifications of the lunar surface. Even in the map projected by the British Association, we must remain content with drawings of the various parts as seen with different instruments. If the portion thus observed be viewed with higher powers, new features will be seen. Thus, the interior of a mountain viewed through Earl Rosse's greatest telescope was found covered with a number of minute blocks, which were invisible in the three-foot mirror. It would thus be unfair to compare the pictures taken by different instruments, or even with the same instrument by different observers. It is very probable that the idea of actual changes takingplace on the moon arises from these circumstances. Mr. Webb, who has devoted great attention to this subject, believes, however, in actual physical alteration of surface, or of obscuration arising from volcanic action or by changes in a possible lunar atmosphere,—a suggestion due to Schroeter. It is to be remembered, that it is only in the most minute details that those changes have been perceived. Mr. Webb thinks that the eruptions lying between *Copernicus* and *Eratosthenes* have taken place during the present century; but this opinion is derived solely from a comparison of the maps of Schroeter and Gruithuisen; and the other changes mentioned by him are founded on similar grounds. It may be mentioned incidentally, that Maedler reckoned 20,000 craters on the moon's surface as visible in his telescope of four-inch aperture; and the patience necessary for mapping those may easily be imagined. Perhaps the beautiful photograph of Mr. De La Rue may be brought to such a state of perfection as to give all the minutiæ visible on the lunar surface, as that eminent observer has already completed one whose diameter is comparable with that of the large map of Maedler. Until a much more searching scrutiny has been made, judgment must be suspended on changes in the moon. The "rills" already mentioned in the interior of *Gassendi*, which were detected by the writer in 1854, might be taken as decided marks of change, because not seen in previous charts. But it has since been found that they were already seen by Maedler many years before that time, only that they were discovered subsequently to the publication of his large map, and making use of the great Dorpat telescope.

PHOTOGRAPHY AND SOME OF ITS APPLICATIONS.

BY THE EDITOR.

WE doubt if there ever was a discovery whose applications are more numerous, and whose results are more universally distributed than those of Photography. In every part of the civilized world, the photographer holds a certain status in society; and although in some instances we find him combining the pursuit of the "fine arts" with an occupation of a less ambitious order, he nevertheless affords us an example of the ubiquitous character of his calling. The products of the printing-press are not now more common than those of the camera; for wherever there is civilization, it is hardly too much to say there is also photography. Nay, we even fancy that among people who, in every other respect, recall the habits of barbarians, *cartes de visite* are to be found. The photographic portrait has become one of our institutions; one, in fact, of the requisite conditions of our existence and happiness; and it is to be hoped that when Macaulay's New Zealander stands upon the ruins of London Bridge, our indestructible photographs will afford his philosophic mind a clue to our former greatness. We have said that the results of photography are everywhere among us; but we would ask how many there are who are familiar with the great principle upon which the art is based, or are acquainted with any save its most common-place applications? From a conviction that comparatively few know much, either of the theory of photography or of its applications to the arts and sciences, we have thought that a short paper on these two subjects would be acceptable to our readers.

Photography, a word derived from two Greek roots, signifies the process of writing with light, and is a strictly literal expression of the phenomena which take place when a prepared plate is exposed in a camera. The principle upon which the process depends is an exceedingly simple one, and is, briefly, that of the chemical action of sun-light upon certain salts. Among the thousands of combinations which chemists have effected in their laboratories, there are some which, when exposed, as perfectly clear solutions, to the action of light, undergo decomposition, the base being set free in the insoluble form as a black or coloured deposit. Of these compounds, the salts of silver (especially the nitrate) are the best known. When solution of nitrate of silver is exposed, in contact with organic matter, to the action of the sun's rays, the base (oxide of silver) separates from its acid as an insoluble black substance. The common "marking ink" of the housekeeper is an apt illustration of this fact; it is a solution of nitrate of silver, usually sold in small black bottles, which prevent the action of the sun's rays upon the salt. When this material is placed upon linen, and exposed to the light, it undergoes the usual change, and leaves a black, permanent stain upon the fabric. This is the simplest illustration of photography that can be given. But let us select another. If we take a piece of paper which has been wetted with solution of nitrate of silver (lunar caustic), and allowed to dry, and having fastened closely to it a piece of fern, expose it to the action of sun-light, we shall find that all those portions of the paper which have been unshaded by the fern become black, while the covered portions retain their ordinary colour, thus leaving us an outlinear representation of a fern, in white, upon a black ground. If, however, having removed the fern, we now again expose the paper, our picture disappears, and we have left only a blackened sheet. What is the rationale of this? When the paper was first exposed, the nitrate of silver (with which it had been saturated) was decomposed by the sun-light in all those places where it was unprotected, leaving an area of undecomposed nitrate, corresponding to that of the "frond," and when the sheet was a second time exposed in an unprotected state, this white space also was blackened. So far, the reader will say, the photographic process is a very inefficient one. Not so, however. It is evident that if, after the first exposure, we brought the paper to a darkened room, and then, by means of certain chemical solutions, washed out all traces of the undecomposed nitrate of silver from the clear unstained portion of the paper, our picture would then be an enduring one. Now, this operation, which is termed *fixing*, can actually be performed. A solution of hyposulphite of soda will dissolve away all the undecomposed nitrate, and thus render the representation unalterably fixed. The term "fixing" is fairly applied, as far as the general result of the process is concerned; but the operation is fundamentally one of *removing* the unaltered silver salt, and leaving that which has been already *fixed* by the *actinic* (ray-acting) influence of the sun.

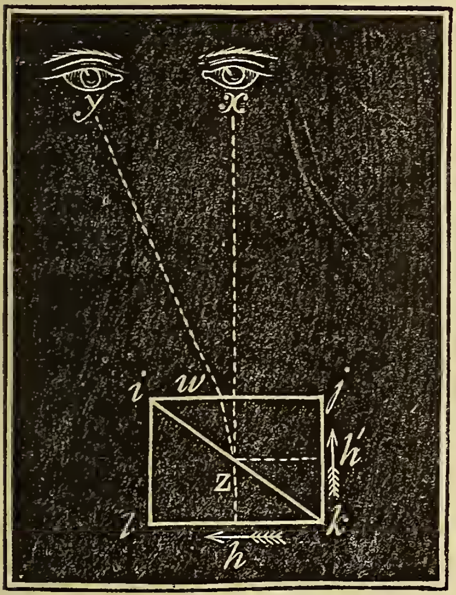
The foregoing is a very elementary sketch of the photographic process. The earlier photographs, or, as they were styled (after their inventor, M. Daguerre), daguerreotypes, were done upon copper plates which had been previously silvered. These having been exposed in the camera—an instrument in which an accurate picture of surrounding objects is thrown upon the introduced plate—were afterwards fixed, somewhat in the manner we have above described. The daguerreotype gave way to a cheaper process, in which a film of collodion (gun-cotton dissolved in ether) deposited upon glass was made to receive the sensitized solution; and this, in its turn, has almost given way (as a picture) to the paper process. In all the various methods of photography now employed in portraiture, the principle is the same: a salt of silver, more frequently the iodide, is exposed in a camera, and an image thrown upon it by the agency of the latter. The light falling upon different parts of the plate with different intensities, produces a decomposition of the silver, corresponding to the lights and shades of the picture. The plate is then removed to a dark room (to prevent the further action of light), developed by special solutions, and fixed. Where, however, paper is the medium employed, there is some greater difficulty in producing the required result. Sensitized paper is scarcely as sensitive as either the collodion film on glass or Mr. Daguerrre's plate, and if a picture were taken with it in the ordinary manner, it would be necessary to have it exposed for a very considerable time. Hence, paper cannot be employed in this manner for portraits. How then, it will be asked, are our "cartes" executed? We will explain; for the explanation leads us to a new portion of our subject,—the respective meanings of the terms *positive* and *negative*. The ordinary picture, which is produced in the case of the collodion film on glass, is a positive; that is to say, it is a true delineation of the object it portrays, light representing light, and shade, shade; in point of fact, it is like any picture. In the negative, the state of things is reversed; that which is shade in the positive is light here, and *vice versâ*. In fact, a negative is a positive in which all the shades have been reversed. From this it follows, that if we place a piece of photographic paper beneath a negative, and expose them thus to the sun's rays, we shall have a positive printed upon the paper. This is just what the photographer effects in producing a carte portrait. Without entering minutely into the method of producing a negative or a positive, we may state generally that in the one case, all the decomposed, and in the other, the undecomposed, silver is removed. In taking a carte, therefore, the photographer first procures a negative picture of the sitter, upon a plate of glass coated with sensitized collodion. This he can do in a few minutes; and then, by means of his negative, used somewhat in the same manner as the fern-frond of which we have spoken, he prints off as many positives on paper as he pleases.

The reader is now, we trust, in a position to follow us in our description of some of the more remarkable applications of photography to the arts, fine arts, and sciences. If it has seemed to those skilled in the profession of photography that we have dwelt too much upon merely rudimentary details, we would ask them to remember that there are others to whom our remarks are necessary, in order to render what we are about to describe intelligible. Foremost among the branches of industry in which photography has been employed with advantage, must be mentioned lithography. The discovery of a means of applying the photograph to the stone, and thus of working off copies of sun-pictures in ink, and that, too, with all the velocity which steam-power can achieve, is indeed a grand one. The credit of making it is claimed by two or three individuals, between whom it is all the more difficult to decide, because of some trifling differences in the processes they employ. Thus one candidate has termed his method photo-zincography, a name which is truly anything but euphonious, whilst the others simply use the expression photo-lithography, to designate a combination of the stone and sun-light in the operation of printing. The methods by which the photograph is applied to the stone are by no means complex ones. The mode employed on the Continent, especially in Austria, is as follows:—A special solution of sensitized collodion is poured upon a patent plate, and after exposure in the camera for a suitable time, is converted into a negative. For protection, the picture is then coated with a solution of gutta-percha, and the solution allowed to dry; after ten or fifteen minutes it is again coated, but this time with a solution of gelatine. The next stage consists in removing the film containing the picture from the plate on which it rests; this is done by pasting on thin slips of paper to the four margins of the picture, and then, after the picture has been moistened and the edges separated with a knife, by carefully peeling off the entire surface. Next, it is cautiously dried on a smooth surface, and is then ready for the stone. The latter has also to be prepared. Having been properly ground down, it is removed to a dark room and then receives a coating of a solution of asphalt in chloroform, which, when dry, presents a sensitized surface. Upon this the negative film is now placed and firmly pressed, and then, after being covered with a patent plate, the whole is exposed to the sun-light for about two or three hours. When the exposure has been deemed sufficient, the picture is then acted on with rectified turpentine containing a small quantity of alcohol. This substance dissolves away all the asphalt which has not been exposed to the sun, and in this way leaves a perfect positive print in asphalt upon the stone. When the stone has become dry, the usual lithographic operations, such as etching, &c., may be proceeded with. There is one serious objection to the above process, and that is, that the defects—whatever they may be—of the negative are transferred at once to the stone, and hence, if the picture be an unsatisfactory one, the stone must be washed and re-ground. The mode known as the *transfer* process is, therefore, the one more generally employed in these countries. This simply consists in transferring the image first taken to paper prepared for the purpose, the latter being then pressed upon the stone. The transfer paper is of various kinds, but one of the simplest is that in which the paper, which is to be exposed beneath the photograph already taken, is prepared with gelatine and bichromate of potash, and coated with fatty ink, the latter being afterwards easily washed off with water from those parts unaffected by light. In all processes of photo-lithography the great difficulty is the production of the negatives. These must be of the greatest excellence, for the slightest defect in the half-tones will be terribly exaggerated in the print. Indeed this is so true of photo-lithography that there is a certain class of negatives, such as those of animal structures, containing an immense combination of half-tints, which cannot be applied to stone with anything like successful results.

There is a twin-brother of photo-lithography which is not yet as great a favourite nor nearly so useful a member of industrial society; we refer to the process of applying photography to engraving. The method of producing engravings by lithography has not yet been very successful, though it has produced some wonderful and not to be anticipated results. One of the processes has received the name of *photo-galvanography*, a very sesquipedalian epithet it must be owned, but still one which expresses the meaning of the process tolerably well. It is essentially a combination of a peculiar form of photography with electrolysis, or the deposition of metals by means of galvanic electricity. Of course, in this instance, as in the former ones, a negative of as perfect a kind as possible must be taken, and this is placed over a plate of glass which contains a layer of sensitized material of a particular kind. This sensitized substance is not collodion, but is a compound of gelatine, water, and concentrated solution of bichromate of potash. The effect of exposing a layer of this preparation beneath a negative to the action of the sun is not only to produce a picture, but to give those portions of the layer which have been least exposed to light a power of swelling to a greater height under the influence of water than those portions which have been more fully submitted to the sun's action. What a wonderful result this is! A picture is produced which, when thrown into water, absolutely presents relief-elevations and depressions in accordance with the lights and shades. As soon as this gelatine plate has been sufficiently exposed, it is then (after removing excess of bichromate) given a series of coatings of a solution of nitrate of silver in alcohol, the silver being then deposited in the metallic form by applying to it a solution of pyrogallic acid. In this stage we have a gelatine surface picture, coated with metallic silver. The plate is now thrown into water, and in a short time the picture appears in relief. All the photographic operations are now over. The picture in relief has been produced, and it presents a surface of metallic silver, upon which copper may be easily deposited. Space does not permit us to describe the further phases of the photo-galvanograph, which, however, are merely those observed in the production of a stereotype: by galvanic action metallic copper is deposited upon the gelatine plate, and in a few days a perfect copper-plate, which may be employed for printing, is produced.

Of the applications of photography to the *fine arts* there are two or three that are especially worthy of notice—*photosculpture*, the *crystal cube miniature*, and the *burnt-in photographs in china and glass*. Of these, the first, which is the invention of M. Willième, a Frenchman, is perhaps the best known in England. M. Claudet, who tried to introduce photosculpture into these countries, has taught us all about it, though we fancy he has not found the invention valuable in its commercial bearings. To those unfamiliar with the processes of photosculpture it is almost impossible to conceive that by any photographic appliances a perfectly solid bust of a sitter can be obtained. Yet is it quite true that photography is capable of doing all that M. Willième contends for. We may observe, however, that the sculptor's chisel is brought into operation, and that though the greater part of the work is chemical and mechanical, the hand of the artist is required to give those finishing touches, which no mere physical contrivances could effect. The principle of the process of photosculpture is based upon the fact, that a solid image is nothing more than a multitude of profiles placed side by side like the radii of a circle. If a sculptor was acquainted with the exact nature of each of these profiles, his work would be easy enough. Let us see how M. Willième utilizes this fact. The person whose bust is desired, is placed in the centre of a circular room in whose walls, at equal distances from each other, are twenty-four cameras; at a given moment the photographers expose the plates, and thus simultaneously twenty-four different views are taken of the sitter. The outlines of these constitute as many profiles, which are brought to the assistance of the sculptor in the following manner. The glass slides containing the figures are placed in a sort of magic-lantern, and are successively thrown upon a ground-glass screen, behind which sits the sculptor with his block of plaster before him. This block is placed upon a revolving disk, which is graduated. There is also behind the screen an instrument called a pantograph, which we cannot further describe than to say that it is a piece of mechanism, which, in this case, has a style attached to one extreme and a sculptor's chisel at the other, and which is so contrived that as the style traces the outline of the figure projected upon the ground-glass screen, the chisel carves out a corresponding outline upon the block. So far, then, the reader can understand, that as soon as the first photograph is placed in the lantern, its image is projected on to the screen, and the sculptor, working with pantograph, traces out the outline upon the glass and simultaneously chisels out the first profile on the block. As soon as this has been done, photograph No. 2 is placed in the lantern, the graduated disk on which the block rests is turned round 1-24th of its circle and the second profile is carved out. These operations are repeated till the whole twenty-four photographs have been used and as many profiles cut out upon the block, which has by this time described a complete revolution. The consequence of all this is a bust, which, when it receives a few touches from the hands of a skilled sculptor, is completed. Such is the process of photosculpture; and though, at first, the idea of a solid bust, produced by photography, seems very remarkable, when the details are explained much of our wonderment ceases. We believe we are correct in stating that the discovery has not proved valuable in a pecuniary point; the great expense of the preliminary operations and of employing skilled artists to complete the bust having rendered it inaccessible to all but the wealthy.

The crystal miniature is an application of photography to portraiture, which was discovered and patented a couple of years since by Mr. Henry Swan. The invention is an exceedingly ingenious one, and the effect produced, whether in point of novelty or beauty, is exceedingly remarkable. In this form of portrait the image of the sitter appears to exist as a solid reality in the centre of a mass of crystal, and has, when first looked at, a startling effect. The portraits of some of our men of eminence—those of Lord Brougham, for example—which are exhibited at the Crystal Cube Company's establishment at Charing Cross, are singularly true and life-like. In some of them, you can almost fancy the possibility of plucking at the nose (if such an operation were desirable) of the inhabitant of the crystal cube. The effect of solidity in the case of this application is almost equal that of the stereoscope, and is the result of optical phenomena in some measure the same as those of Wheatstone's instrument. The diagram beneath will help to explain the principle of Mr. Swan's device. To produce the effect, two photographs (*h* and *h'*) taken at the proper angles, and two rectangular prisms (*i j k* and *i l k*), whose angles are somewhat different, are required. The prisms are placed upon each other, so as to produce a nearly square block of glass, and the photographs are arranged, one (*h*) behind this block, and the other (*h'*) at the side. If now the two eyes (*x* and *y*) be placed in front of the crystalline cube (a little less to the side than is indicated in the diagram), it will happen that each eye will perceive one particular image, and one only, and thus the stereoscopic effect will be produced. This must follow from the laws of reflexion and refraction. The rays of light proceeding from the photograph *h'*, will pass laterally inwards till they meet with the polished surface of the lower prism at the point *z*; from this they will be reflected at an angle equal to that of their incidence, and not meeting the surface (*i j*) of the upper prism vertically, they will be refracted on entering the air, and will pass on to the eye *y*. The pencils of light from the photograph *h*, will be transmitted without either refraction or reflexion, and will enter the eye *x*, and thus perfectly binocular vision will be produced. It is necessary to mention that the photographs are generally executed on some transparent medium, such as talc, which is then attached to the prism. From the expensive character of the apparatus employed, and the difficulty of giving the photographs transparent colour to exactly the same extent in the two, the crystal cube miniatures have not yet been sold at a price calculated to make them as popular as the "carte," but we believe Mr. Swan is now engaged in experiments, with a view to discover a method of rendering the whole process simpler and cheaper.



The public have not seen, as yet, many of the photographs produced by the "burning-in" process; but no doubt they will soon be familiar enough with these handsome and really important applications of the science of sun-printing. Some of these, which were exhibited at the last *conversazione* of the Royal Society, were extremely pretty. When examined by reflected light, they gave one simply the idea of a plate of white or opal-like china, having a rather indistinct picture upon, or rather slightly beneath, its surface; but as soon as they were placed so that the light passed directly through them, the picture assumed a prominence and elegance of finish which could hardly have been anticipated. They are prepared by what is termed the *burning-in* process, a method whose nature is expressed in its name. The photograph may be burnt into either glass or porcelain, but must be taken in a special manner. The plate must first be coated with a varnish of benzole, indiarubber, and collodion, and on this the sensitized collodion must afterwards be placed. When it has been exposed in the camera, the image requires to be developed, strengthened, and washed, according to prescribed processes which we have not sufficient space to describe. After these operations have been gone through, the plate is immersed for some hours in either a bath of platinum, if it be desired to have the picture of a greenish-black tone, or in solution of chloride of gold, if a golden tint is required. The image is now washed, either with a solution of cyanide of potassium, or with strong ammonia, and it is then covered with a thick varnish of indiarubber, and heated in a "muffle." The organic matter is thus destroyed, and a purely metallic picture remains upon the glass. The only thing to be done now is to vitrify this image, and this is effected by means of a flux of either borax or silica. The most important feature in connection with these photographs is their permanency; the pictures are painted in pure metal, and this, by its vitreous envelope, is entirely removed from the action of the air, moisture, &c. Hence there is every reason to believe that such photographs will remain unchanged for ages; and if such a belief be correct, it is most probable that a thousand years hence photo-portraits of our Carlyles and Tennysons will figure in the National Galleries of the period.

The applications of sun-printing to science have been neither less important, nor less interesting, than those we have already touched on. Microscopy—thanks to the exertions of Dr. Maddox, Mr. S. Highley, and others—has profited largely by photography. Instruments are now employed which are virtually combinations of the compound microscope and the camera, and with these perfectly accurate and enormously magnified pictures of microscopic objects can be taken with great facility. Those who were present at the late *soirée* of the Microscopical Society are aware to what extent Dr. Maddox has carried his labours in this field. There is not much of special interest to be said concerning the mode in which these photographs are taken, but there is a mode of exhibiting them which merits attention. With the oxyhydrogen lantern, gigantic views, some feet in length, may be obtained of objects whose natural size is only to be measured by the thousandth of an inch. This is a fact of much importance to lecturers; for by this means, crude and ugly diagrams may be dispensed with, and pictures of unquestionable truthfulness substituted.*

Of all the useful labour which photography has done for man there is, however, no one feat which she has accomplished more extraordinary than that by which she records the results of the philosopher's investigations. The story of Aladdin's lamp—that glorious tale of the "Arabian Nights"—which used so to excite our boyish emotions, told us of no greater wonders than those of photography. The mysterious "genius of the lamp"—that strange being whose powers were so unlimited—was but the prototype of another spirit—actinic force—which promises even greater marvels than those achieved by its eastern predecessor. When we inform our readers that the night-work at the Greenwich Observatory is now abolished, and that through the long dreary hours when the human world is at rest, photography is silently and steadily recording the phenomena of the physical universe, our Spirit of the Lamp ceases to be mythical. It would be impossible in the limited space at our disposal to enter upon a description of the immense variety of contrivances employed in the "Observatory" for recording the variations in the movement of the several instruments which such an institution possesses; but we shall give an account of the means by which the movements of the magnetic needle are handed down to us by photography. The needle is so suspended that the apparatus suspending it carries a small concave mirror of long focus, which moves uniformly with the needle itself. Placed opposite to this is a lamp (gas or photogen), through a narrow slit in which a bright spot of light falls on the mirror. At a distance of about twelve feet from the latter there is a piece of mechanism, comprised of a cylinder bearing photographic paper, and attached to a strong time-piece, so that it revolves slowly in twenty-four hours. The light which passes from the lamp travels to the mirror, and is reflected by it (the rays having previously been made parallel by a lens) on the slowly-revolving cylinder. As the magnet moves slowly to the east or the west, so does the mirror, and so also does the spot of light upon the paper; and the consequence is, that at the end of the twenty-four hours the paper, when removed from the cylinder, contains a series of curves which pass to the right or left of the centre, and thus indicate with the utmost exactness the movements which the needle has performed. In the case of the barometer a somewhat similar device has been employed; but in this case the mirror has been dispensed with. The light is allowed to traverse the barometer before passing on to the prepared paper, and as it can only pass at a point above the level of the mercury, the elevation or depression of this fluid is thus made to register itself. Thus, in the case of these several instruments does photography all the night long perform its useful office, and confer benefits on mankind which only those who know the value of accurate scientific statistics can appreciate. We may mention, in passing, that the means of employing photography in the "Observatory" are due entirely to the inventive mind of Mr. Brooke, a gentleman whose name our microscopic readers have often met with. Science has also profited by sun-pictures of the moon—a sketch of one of which appears in our present number—of great eclipses, of the dissected body, and—through the medium of the ophthalmoscope—of the interior of the human eye.

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* Some very good specimens of these photographs of microscopic objects for the lantern may be seen at Mr. Highley's establishment, Green Street, Leicester Square.

It now only remains for us, in concluding this paper, to say a few words on the subject of two or three photographic novelties which can scarcely be classed under any of the above heads. First comes that of the *binograph,* a form of picture which bids fair to become very popular. In the "carte" binograph one's "double" is represented; in the same picture may be seen two or even more representations of the same individual. If the result were arrived at by placing two or more pictures together, the effect would not be curious; but as it is, it is an interesting phenomenon. Fancy a portrait of a man having a pugilistic encounter with himself, or a woman pushing herself along in a perambulator, or a gentleman giving his double a light for his cigar! Yet all these portraits can be easily produced in the following manner. The camera having been adjusted, and the sitter placed at the right side of the field in the first position, a curtain of the blackest velvet is hung at a short distance from the lens in such a way as to cut off the remaining or left half of the field. The plate is now exposed for a few moments and covered, and the positions of the sitter and the velvet curtain are reversed, and the plate is once more exposed. When developed there will be but one picture, in which the two figures of the one individual are represented in different attitudes. This is what is termed a binograph. The invisible photograph is another of the recent innovations. When first examined, it appears to be a blank sheet of paper devoid of interest; but when it has been immersed in water for a few moments, it becomes an exquisite transparency, which, upon being again dried, returns to its former condition. The paper, upon which the photograph is taken in the usual manner, is prepared by immersion in a solution of gelatine of twenty grains to the ounce, drying and subsequent immersion in solution of bichromate of potash and water. Photographs on enamel and china are other interesting varieties, whose merits we cannot now discuss.

We have been able to sketch only a few of the many industrial and scientific applications of which photography is capable, but we have written enough to show that the subject is one of the highest importance, and worthy of the most studious attention. Photography is a veritable "slave of the lamp," who patiently awaits our desires, and who is capable of displaying still greater wonders than those which she has already achieved, should we demand further proofs of her powers.

Note.—Since this article was "set up," we have seen a description of a new process of photo-engraving, which promises to eclipse in excellence and beauty everything of its kind which has heretofore been attempted. This novel method, which we owe to Mr. Walter Woodbury, we shall describe fully in our next number. At present we can only state, that one of the principal features in the process is the employment of a printing material composed of gelatine and Indian-ink, or some other colour.

REVIEWS.

THE PHILOSOPHY OF ZOOLOGY.*

HE that questioneth much, said Lord Bacon, *shall learn much;* and it is undoubtedly true of all those inquiries which are made with the object of discovering some certain fact or facts. If there is something sought for which can only be arrived at as the result of prolonged research, he who is engaged in the investigation will assuredly amass much information. Indeed, in all cases where the seeker for knowledge of an important kind questions much he shall learn much. In no instance can this be said with greater truth than in the search for the laws of Nature which rule the phenomena of organic life. To discover those laws of the great cosmic statute-book should be the highest aim of the philosophic naturalist, who should rather seek to interpret the mysteries of the organic realm, than to simply look for pleasure in the survey of Nature's works. But it not unfrequently, nay, it but too generally, occurs, that the naturalist ceases to be a philosopher in becoming a lover of Nature. In his admiration of organic phenomena he gives way to the pleasures of sensual enjoyment, and cultivates æsthetic feelings rather than power of analysis. Hence it is, that of the legion of naturalists who are daily engaged in the examination of natural objects, but very few indeed have the faintest claim to be termed philosophic. Their labours display prolonged observation, and a due and even enthusiastic appreciation of the beautiful, but beyond this they do not go. Our so-called scientific journals teem with articles descriptive of the varied and novel forms of organic existence which present themselves on all sides to our notice; but how seldom they contain anything approaching to profound generalization! How little is achieved in their pages toward a solution of the complex scheme of organic life?

It does happen, however, now and then, that some naturalist-worker, with more lofty purpose than his fellows, strives to arrange and classify the materials which have for years lain in chaotic disorder on the lumber-shelves of scientific annals. Bringing a logical mind to bear on the confused collection of facts and inferences, he separates the former from the latter—the grain from the chaff—and proceeds to add something to our previous knowledge of Nature's laws. Such men are the real supporters of science, which, without them, would dwindle into a contemptible empiricism; they stand out in all ages as the landmarks of philosophy, and are respectively associated with the links which constitute the chain of natural science. We have been led to these remarks by an examination of the two works now before us; essays which, notwithstanding their imperfections, tend more to advance the philosophy of zoology than a thousand of the ordinary treatises which our scientific publishers so lavishly supply us with. The two writers, M. De Quatrefages and Dr. Ogilvie, have chosen pretty nearly the same subject for investigation—that of the laws regulating the changes which animals undergo from the period of ovum to the condition of sexual adult; but the former has been the first in the field, and has confined his attention nearly exclusively to animals, while the latter, who has just made his appearance as a teacher in these departments of knowledge, has extended his inquiries to the vegetable kingdom. There are two very well-marked distinctions between the views and generalizations of the two writers. Those of our readers who are acquainted with comparative physiology, are aware that the phases through which animals pass from the time they leave the egg till they arrive at maturity, are of a very varied and complex character, and are by no means alike in all classes. They are further aware that in some cases the intermediate changes occur within the envelopes of the ovum, while in others they are capable of being closely examined by the naturalist, since they occur subsequently to the rupture of the shell-bag. To these alterations the term *development* has been given when they occur within the ovum, and *metamorphosis* when they take place external to the egg. Such alterations are common to all animals; but it happens that in certain groups of creatures phenomena of apparently quite another kind take place, which, as it were, approximate these beings to plants. From the fertilized ovum there springs an independent organism, having definite characters, and capable of supplying itself with food. This product, though to all appearance a distinct and perfect animal, is devoid of a reproductive system, but is capable of either increasing its own extent or producing distinct descendants by a process of gemmation. Under such conditions it may remain for a period of time, longer or shorter, according to circumstances, but eventually it develops reproductive organs, which in some cases remain attached, in others become free and floating, and by the sexual combination of the elements of these an ovum is produced, and thus the vital circle is completed.

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* "Metamorphoses of Man and the Lower Animals." By A. DE QUATREFAGES, Professor of Natural History in the Museum of Natural History at Paris. Translated by HENRY LAWSON, M.D. London: Hardwicke. 1864.

"The Genetic Cycle in Organic Nature," &c. By GEORGE OGILVIE, M.D., Professor of the Institutes of Medicine in the University of Aberdeen. Aberdeen: A. Brown & Co. 1865.

These curious deviations from the condition of things we meet with in the higher animals, Messrs. Quatrefages and Ogilvie have set themselves to account for, and in doing so they have correlated the various phenomena, or rather shown us their correlation, in the expression of very simple laws. Let us deal first with M. de Quatrefages. The processes of *metamorphosis* and of *alternation of generations* which we have described are, according to the French *savant*, but different manifestations of one and the same primary phenomenon—development. He commences by showing us that development in the embryonic application, and metamorphosis are identical, and that each is a series of improvements which Nature achieves in an animal she is leading to the mature condition. For the difference in the circumstances under which the two sets of changes take place, he accounts by the following law: — In certain ova, the supply of pabulum is inadequate to the changes which it is required that the animal shall undergo, and hence the young being is ushered into existence as a simple larva, capable of obtaining such a supply of nutriment as is necessary for the alterations it must undergo in reaching the final condition. Alternation of generations, or, as he terms it, *geneagenesis*, is also regarded by M. de Quatrefages as a species of complex metamorphosis. There is a good deal of ingenuity in the way in which M. Quatrefages endeavours to demonstrate his views; and his happy method of illustration, and exquisitely terse style, when added to the really logical force of his argument, must secure him many disciples. Having shown the intimate relation which exists between development within the egg and metamorphosis external to it, he proceeds to give an idea of the association between geneagenesis and metamorphosis, somewhat in the following manner:—"Supposing that a medusa gives rise to an ovum, and this to a polyp-stalk, which has the power of budding, and this in its turn to a medusa, is not the process strictly comparable to the metamorphoses of a caterpillar? Thus, a butterfly gives rise to an egg, this to a caterpillar, and this eventually to a butterfly. All we have to do is to conceive of a caterpillar which has the power of producing others by gemmation, and the analogy is strictly correct." We (reviewer), however, are not quite so sure that our author's analogy is not a little too extended, but we do not the less admire the view which harmonizes so many otherwise incongruous phenomena, and in any case we accept his notion of the relationship of development and metamorphosis most readily. His book reads more like a fairy romance than a "plain unvarnished tale" of science. Yet it is commonplace in neither style nor thought, and it is a work which, while easily read, requires months for the digestion of its contained speculations.

Dr. Ogilvie, who is so well known as the author of "The Master-builder's Plan," has not been so fortunate either in his style or his conclusions as the French Zoologist. His treatise displays considerable erudition, but its materials are badly arranged, and its style is far from fascinating. Nevertheless, it merits a careful perusal, for it is evidently the result of deep thought, and a careful investigation of the works of others. We have not space at our disposal to enter upon all its merits or demerits, but we will just glance at the more important conclusions which its author has formulated. Looking upon the entire life of an animal as a species of cycle, he divides it into three stages. The first, or *Protomorphic*, is that in which the animal is not fully formed, and refers to the period immediately subsequent to the departure from the egg. The second, *Orthomorphic*, is that in which the definite form of the animal has been arrived at, but in which the reproductive organs are as yet absent. The third, or *Gamomorphic* stage, is that in which the reproductive system becomes fully developed. In accordance with these three stages, he classifies the alterations of geneagenesis. Thus, those of the Trematodes and mosses, occurring in the first stage, are *protomorphic;* those of the Aphides, occurring in the second stage, are *orthomorphic;* and those of Cœlenterata, which take place during the third stage, are *gamomorphic.* It would appear that one of the objects of this classification has been to show that alternation of generation is not an exceptional process, but one which happens to a greater or lesser extent in every creature, from the highest to the lowest. This latter is the most remarkable of Dr. Ogilvie's theories; and we confess, it appears to us the most far-fetched and indefensible. For example, how is alternation of generation represented among mammals? We let Dr. Ogilvie speak for himself. Treating of *protomorphic* alternations in the higher animals, he writes :—"We may consider the phenomena of embryogeny as presenting a certain parallelism with the gemmation which occurs in some of the lower species (Trematoda, mosses, &c.) . . . . No point in embryogeny is better established than this, that the first result of impregnation is the formation in the ovum of a cellular mass, from one point of which is subsequently developed a fresh axis of growth destined for evolution into the organization, typical of the species, while the original germ-mass disappears as a distinct structure. The embryo, in short, may be said to be budded off from the primordial germ-mass, or *mulberry body,* much as the cercariform larva of the *Distoma* is from the gregariniform product of the Trematode ovum." Clearly from this, man undergoes an alternation of generations, his apparent parent being really his grand one, and the mulberry mass of the ovum being his true progenitor. It seems to us, that in framing such a generalization, Dr. Ogilvie has been rather working out a foregone conclusion than labouring, with a due regard to rationalism, to discover truth. His book, however, will, as we have said, be read with interest; but those who have already profited by the writings of M. de Quatrefages, will hardly bestow on Dr. Ogilvie's labours the patient examination they deserve.

OUR WINES.*

THERE are very few questions of social science which demand at present the attention of the British public, more than those relating to wines. Is wine in any form good, and if it is, which are the best varieties? These are queries which are answered in the little volume which Dr. Druitt has recently issued, and whose matter originally appeared in the pages of *The Medical Times and Gazette.* For many years the subject of intemperance received the careful attention of the author, and when the French treaty caused an influx of light continental wines into these countries, he determined to record his observations upon their qualities and effects. In the present work he has done this rather fully, and his remarks, as expressing the opinion of a single individual who has endeavoured to draw careful conclusions, have a special value. He is evidently an advocate of the light French, Greek, and German wines, not that he decries good Port and Sherry, but because, as he says, it is almost an impossibility to obtain either of the latter forms in a state of purity. Besides, he contends that the national wine of England was Bordeaux or Burgundy, till near the end of the seventeenth century, and he shows that in the beginning of the eighteenth century, when French wine was banished from England, "the educated and intelligent classes grumbled as much then as they would now if all wines were banished save South African. As cheap wine is now called Gladstone, so Port was called 'Methuen.' The stage reviled it, the poets had all a fling at it, as a dull, muddled, humble, thick, flat, cheap stuff." Armstrong, who was a physician as well as a poet, remarked :—

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* "Report on the Cheap Wines from France, Italy, Austria, Greece, and Hungary; their quality, wholesomeness, and price, and their use in diet and medicine." By ROBERT DRUITT, M.R.C.S. Pp. 179. London: Renshaw. 1865.

> "The man to well-bred Burgundy brought up
> Will start the smack of *Methuen* in the cup."

Dr. Druitt has a good deal to say about the wines sold in this country as Port and Sherry, and we think there can be very little doubt that he is right in thinking that many of them are manufactured, or are, at all events, materially altered on their arrival in England. He is exceedingly severe, almost to the degree of being abusive, with those who indulge in the habit of ordering special wines for patients, on the principle that they contain medicinal ingredients. Speaking of this practice, he remarks, "I am ashamed to hear that such things are talked of in medical consultations. I have been told that an eminent physician in consultation asked, 'Don't you think we had better order our patient to drink Carlowitz wine ?' 'Why ?' 'Because it contains phosphuret of iron.' 'Who says so ?' 'Why, have you never heard that it was ordered for the Lady Dulciana, and for the rickety eldest son of the Marquis of Carabbas, because it contains phosphide of iron ?' My informant bowed in grim silence, hoping the day would come when physicians would disregard the logic of Mrs. Gamp." This quotation from our author's essay gives in a very brief space the general tone of his book. In every possible instance he makes an onslaught on the too commonly adopted system of accepting theories which have no facts to support them ; and in all such cases we cordially sympathize with him. It would hardly have been too much to expect that so determined a rationalist in matters professional should have been extremely cautious in advancing views of his own. It was naturally to be expected that one who can so clearly discern the fallacy in the argument of others, would support his own opinions with an overpowering force of logic. We regret, however, to perceive that this is not the case. The statements relative to the dietetic value of particular wines, which Dr. Druitt commits himself to, are in most cases supported by his own experience. That experience may, no doubt, be a valuable one, and we have every reason to suppose that it is so ; but it nevertheless behoves us in all questions relating to food, to look for something more than the *ipse dixit* of a writer. Dr. Druitt suggests the employment as constant articles of diet, of those light wines, which several energetic, and shall we say interested merchants, are striving to obtain a sale for. He contends, that from his knowledge of the action of these wines upon his own system and that of his patients, they must be beneficial ; and mayhap his conclusion is just. On the other hand, it may be objected that the limited observation of a few individuals is hardly sufficient to warrant us in calling upon our fellows to use any particular form of diet to which they have not previously been accustomed. The light Greek and German wines are exceedingly agreeable drinks in summer; but still there remains a question as to their wholesomeness. They are of endless variety and composition, and before recommending their general employment, we think it would be as well to have their constitution and their physiological action more carefully investigated. Such an investigation is, we need not say, one of the most difficult things in the world to carry out satisfactorily; but it is none the less necessary on that account. Indeed, it seems to us, that something in the shape of a medical commission of inquiry would be the only proper means of deciding the question, which Dr. Druitt answers in the affirmative. The volume before us is vigorously, in some instances a little too vigorously written, but is very agreeable reading for all that. We would, however, warn the author against pushing the "slashing style" too far. We do not at all agree with him in thinking that the valuable or noxious qualities of a wine may not be predicted from its composition. He is just too much of a practical man. It is all very well to say that the only tests of a wine are the questions, "How do you like it?—Does it agree with you?" But if this argument were strictly applied, we think the tables would in many cases be turned upon our author. There are at least ninety per cent. of our present wine-drinking population who would say that they like their Port and Sherry (much as they may be "fortified"), and these wines agree very well with them. Besides, one of the most powerful arguments which the author adduces against the employment of low-class "Sherries" and "Ports," rests upon a knowledge of their chemical constitution. Had Dr. Druitt laid down his views in a calmer spirit, we think they would have been found more convincing; but somehow or other they are, like our sherries, "fortified" with a spirit—that of enthusiastic advocacy—which, though it gives them pungency, deprives them of much of their digestibility. If we accuse Dr. Druitt of too much enthusiasm, we must do him the justice to add that we are convinced he is thoroughly sincere. We think that the work before us has been somewhat hastily put together, and therefore we pardon the following strange piece of information, which is afforded us in the Preface:—"The term *empirical* signifies the *practical men* who judge by results!" The humour, too, of the Doctor's remark, that the two cardinal points of a man's moral nature are his purse and his stomach, we have failed to perceive. The "report" is on the whole a very interesting volume, and it merits a careful perusal, if for no other reason, because it is the work of an able medical man, who gives his own experience, and is not a mere volume of puffery, like some productions which shall be nameless.

A MANUAL OF GEOLOGY.*

THE Manuals of Messrs. Galbraith and Haughton have already won for themselves such a world-wide reputation, that it is only necessary to announce a new addition to the series in order to establish its circulation. Professors Galbraith and Haughton, who are both "fellows" of Trinity College, Dublin, and each of whom is distinguished as a teacher in his own special department of science, long ago issued a series of manuals upon the subjects of pure and mixed mathematics. We believe we are correct in saying that these treatises, which commanded a most extensive sale both in this and their own country, were really the result of the labours of Messrs. Galbraith and Haughton themselves. Some time since they projected a new series of manuals devoted to the natural and physical sciences, which, though brought out under their superintendence, were written by gentlemen specially selected. Of these, the manual of the Metalloids has already met a favourable reception at our hands. The volume now before us is upon the subject of geology, physical and palæontological; and though its author modestly regards it as "an introduction to the more systematic treatises of Lyell, Dana, Jukes, and others," we have no hesitation in expressing our opinion that it is infinitely better suited to the wants of the average student than any of the works alluded to. It is written in clear and forcible language, and as the report of a series of lectures delivered in the University of Dublin, it cannot fail to reflect the highest credit upon the scientific status of Trinity College. To descant upon the author's merits as a geologist would be superfluous; Dr. Haughton is well and creditably known to all geologists, English and continental, and those who know him as the editor of the *Dublin Quarterly Journal of Science* are often amazed at the number and importance of his published researches. In point of arrangement his manual does not differ very materially from those of other writers; but it is remarkable for the introduction of some new features, and for the happy faculty which the author in most cases exhibits, of not saying more than is necessary. The besetting sin of most manual writers is verbosity; they seem to start with the conclusion that students who desire to learn are a very unintelligent class of men, and that the oftener they repeat a statement the more likely it is to be apprehended. This is a fatal mistake. The student requires to have the ideas which he wishes to grasp, conveyed to him in the clearest and shortest manner possible, and this is just what Professor Haughton does. He treats of the origin and composition of the globe in the first instance, and then passes on to such subjects as the constitution of rocks, preservation of fossils, geological time, &c. His chapters on the structure, characters, and geological relations of fossils are exceedingly good, and are accompanied by diagrams, on the curve plan, which indicate the distribution of fossils through time and space. To these latter we would particularly direct the attention of teachers of geology. There is only one part of Dr. Haughton's manual against which we would raise our voice, and that is the final chapter, in which he rather summarily disposes of Mr. Darwin's theory. Professor Haughton has all along been an anti-Darwinian, and one too of a formidable character ; but we do not think that in his present attack upon the theory of "natural selection" he has been very fortunate. He attributes to the theory the assumption of a mode of causation which its advocates do not adopt for it, and then he proceeds to demolish it by an illustration which we think can be made to tell in favour of Mr. Darwin's views. We almost hesitate to say it, but we do think Mr. Haughton has not stated the Darwinian theory fairly : he seems to think that the belief of Darwinians is, that one series of animal is the cause of a second series, because the second succeeds the first. We admit that such an induction would be both shallow and impeachable ; but we do not think it is that of the Darwinians. They believe that alterations in the great physical operations of the universe, co-operating with certain physiological laws, have produced the several kinds of animals and plants we see upon our globe. Professor Haughton imagining that they regard succession and causation as almost equivalent terms, shows that to argue that that which precedes, causes, is illogical. "We know," he says, "that winter precedes spring, spring precedes summer, and summer autumn ; but no person would say that winter is the cause of spring, spring the cause of summer, and so on." What is here alleged is undeniably true, and forms an admirable analogy by which to illustrate Darwinian views. Winter, spring, and autumn are names given to those distinct conditions of the atmosphere which have followed each other in succession as the expression of as many changes in astronomical operations. If the relation of our planet to the sun were gradually or suddenly to undergo an alteration, so would the seasons. Just in a similar manner with organic existence ; it too is but a collection of phenomena dependent upon the ordinary physical conditions, such as those of the air, food, temperature, climate, &c., for their manifestation. As the conditions alter, so will the phenomena. Animals are always varying, and only those whose frames are in adaptation to the surrounding conditions can be perpetuated. The concluding passages of Professor Haughton's volume contain an argument utterly incontestable. "Surely the animal that grew from a monkey, which monkey had its origin in a lower type of life, that again proceeded from still lower forms, cannot hope to live beyond the time when his perishable body shall return to the elements from whence *they* (*sic*) came. It therefore seems to me that the retention of a belief in the resurrection of our bodies, and in an immortal future, is inconsistent with these natural theories of life upon the globe." Very high praise is due to the Messrs. Longman for the manner in which the volume has been printed and illustrated. Some of the engravings, and especially those upon a black ground, have been deliciously executed.

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* "A Manual of Geology." By the Rev. SAMUEL HAUGHTON, M.A., M.D., F.R.S., Professor of Geology in the University of Dublin. London: Longman & Co. 1865.

SEA SHELLS.*

FEW who know anything of shells, or of dredging for them, are unfamiliar with the name of Mr. J. Gwin Jeffreys, who has now, through his publisher, issued the third volume of his splendid treatise on Conchology. In this part of his work he describes the remaining Conchifera, the Solenoconchia and the Gasteropoda, as far as the genus Littorina. In each case his accounts of the families and species are both scientific and popular; that is to say, they contain reading both for the *savans* and the general public. Thus he commences his account of each species in the orthodox fashion; giving its synonyms, habitat, distribution, technical description, and list of varieties; and then he adds a deal of interesting matter relating to the natural-historical and commercial bearings of the mollusk in question. The chapter upon the Littorina, or, as it is more frequently termed, the periwinkle, is full of interesting details. "The old English name of 'periwinkle' is supposed to have been a corruption of petty winkle, or wilk. Lister says that the Scarborough fishermen called them *couvins;* and he adds, that they were much sought after by the Flemings. According to Dale, they were called in Suffolk *pin-patches.* The ancient vernacular names for them were, in Swedish, *kupunge,* in French, *bigourneau.* Throughout Shetland they are known as *wilks.* In Ström's time, the Scandinavians used to believe that whenever these shell-fish crept far up the rocks, it indicated a storm from the south. . . . . The female produces about 600 young ones, which are clustered in a vascular ovary situated in the upper part of the body. The statement that the common periwinkle is viviparous seems to be disproved by the fact that it is eatable at all seasons of the year, and is never gritty, which last would certainly be the case if it contained testaceous fry." It would appear that the periwinkle is a much more important article of diet than is generally imagined. In Mr. Hyndman's report to the British Association, on the operations of the dredging committee of Belfast (1857), it is stated that at that place periwinkles are gathered and exported to London in large quantities. The trade has been carried on by one person for the last twenty-five years, who employs three horses and a mule to draw them, besides employing boats, &c., and paying about £60 weekly in wages during the season. The supply at Billingsgate is about 2,000 bushels per week for six months, from March to August inclusive, and 500 bushels per week for the remaining six months. The number of persons employed in gathering is at least 1,000, and as many more in selling. The coloured frontispiece to Mr. Jeffreys' book represents a piece of timber eaten through by the *Teredo Norvegica,* and is well executed. We cannot, however, award much praise to the publisher for the manner in which most of the plates have been executed. The drawings have a meagre, unfinished appearance, and the intended effects of light and shade say very little for the artist's pencil. The volume, however, is a good one, and intending conchologists will do well to purchase it as a profitable sea-side companion.

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* "British Conchology." Vol. III. Marine Shells. By JOHN GWIN JEFFREYS, F.R.S., F.R.G.S., &c. London: Van Voorst. 1865.

ICE-CAVE EXPLORATIONS.*

CLEARLY there are other means of obtaining a reputation at the risk of breaking one's bones besides those in vogue among the members of that wonderfully insane and unprofitable body the Alpine Club. In the volume before us the author records his experience, not in clambering up Matterhorns, but in descending into the bowels of the earth. Let it not be thought, however, that the latter is much easier than the former. Those who know anything of ordinary caverns, and the difficulties of getting through them, and still more of getting out of them, may form some faint idea of what they should have to undergo in an ice-cavern. The Rev. G. F. Browne records the results of his explorations of the latter in the book lying upon our table, and truly he deserves great credit for his courage. This we should not award him, were his powers of daring merely exhibited after the manner of those who belong to his club ; but Mr. Browne, while exposing himself to perils not much inferior to those experienced in ascending gigantic mountains, has really given more than a mite to science. Fancy leaving a glorious noonday sun, and with a couple of peasants as one's assistants, spending a whole afternoon in exploring the depths of some cavern, a single false step in which might send you to eternity ; digging steps out of the huge walls of ice, and striving to investigate surrounding objects by the misty illumination of a torch ! Such an occupation is at all events one congenial to the heart of Mr. Browne ; and though we certainly do not envy his tastes, we are thankful for his labours. His volume embraces a number of well-written and exciting narratives, and contains two chapters—those on the *causes of subterranean ice*, and on the *prismatic structure of the ice in glaciers*—which are very valuable. The latter is especially of interest, and we commend it to the notice of our readers, although we do not coincide in the opinion of the writer that ice-prisms are similar in point of origin to the prismatic forms produced in ordinary mud, the latter appearing to us to be devoid of symmetry and uniformity. Mr. Browne's book is a good one ; and while we wish it every success, we venture to express a hope that its author may soon give us a further account of his inquiries.

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* "Ice-Caves of France and Switzerland. A Narrative of Subterranean Exploration." By the Rev. J. F. Browne, M.A., Fellow of St. Catherine's College, Cambridge, and Member of the Alpine Club. London : Longman & Co. 1865.

BRITISH FERNS.*

THERE is none of our native plants more worthy of study and cultivation than the fern, whose graceful outline and lovely colour render it a favourite even among those who have little taste for botany of any sort. Besides, the fern, from the peculiarity of its mode of propagation and the absence of even traces of a flower, has a special interest for the student of vegetable physiology. There is, too, another reason why ferns deserve attention ; they are a better defined section of the plant-world than perhaps any other, and to those who are desirous of comprehending one particular branch fully, they offer many advantages for study. And, indeed, it may fairly be said that ferns are more beloved by plant-seekers—at least among amateurs—than any other divisions of the vegetable kingdom. Else why do our scientific publishers supply us with such a library of handbooks ? We believe there are nearly as many treatises on ferns as there are genera of these plants in the British isles. The volume which is under notice appears in the garb of a fourth or *school* edition, and is a useful and accurate account of our British species. We cannot understand, though, why the author has not adopted some scheme through which the ferns may be identified. His descriptions are very good ; but how is a beginner to make use of them ? Is he to travel through the volume till he hits upon the plant he is in search of ? If so, we can only say we do not envy the beginner, for his task is somewhat like that of searching for a needle in a bundle of straw. Again, we must take exception to the plates ; they are far too few innumber, and the sketches which they contain are remarkable neither for clearness nor elegance. Why did not Mr. Newman adopt some system such as that employed by Mrs. Lankester in her excellent little treatise ? As his book stands, it is almost useless to the beginner, though unquestionably its matter is excellent. We beg, in conclusion, to call Mr. Newman's attention to the fact that the Bristle fern is not to be found either in Torc waterfall, or on the neighbouring mountains of Killarny, as he alleges.

MAN'S AGE IN THE WORLD.†

THIS is a work which we can hardly criticise. Its object is to show that Scripture, in so far as it regards scientific facts, is not to be accepted in a strictly literal sense. An Essex Rector, the author of the work, has certainly taken a very liberal view of scriptural matters ; for example, he admits that man's age is greater than that usually supposed, and that there was not a universal deluge. We sympathize with him in his regret that those who investigate such problems as he has undertaken the solution of, too frequently are actuated by feelings of bigotry; and we commend very highly the calm and thoroughly conscientious spirit in which he endeavours to reconcile Scripture and science. We can say no more than this. The pages of a scientific journal are not the place in which to touch upon questions relating to faith; and on this account we must decline to say how far we think "an Essex Rector" is right or wrong. Of one thing we are certain; he will call down much virulent and undeserved abuse upon his head, while he will have done little either for religion or science. If the great doctrines of theology, as at present taught, are fallacious, they cannot hold against progressive rationalism; whilst, on the other hand, if Science be in error, she will be the first to admit it. We must await the issue in all patience, but meanwhile we urge upon our readers to bestow careful attention to the present work.

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* "A History of British Ferns." By EDWARD NEWMAN. London : Van Voorst. 1865.

† "Man's Age in the World, according to Holy Scripture and Science," By an ESSEX RECTOR. London : Lovell Reeve. 1865.

Pratt's Astronomical Investigations is an attempt to upset the present system of Astronomical laws. It is the enlargement of an essay which was originally sent to the Council of the Royal Society, but was rejected by that prejudiced and illiberal body!! We must leave our readers to judge of its merits.

On Radiation.—Dr. Tyndall's "Rede" lecture is a very important brochure, but contains little beyond what the author has already put forward on many occasions.

Brand's Dictionary shall be noticed fully when the numbers have all been published. The letter addressed to us upon the subject of a former critique, we cannot insert. If we opened our pages to correspondence of this description, we should but weary our readers and effect no service for our correspondents.

Homes without Hands.—The review of this excellent work it has, we regret to say, been found necessary, through want of room, to postpone to our next issue.

SCIENTIFIC SUMMARY.

AGRICULTURE.

Practice with Science, is the title of a series of valuable papers on various agricultural subjects, which has just been published by Messrs. Longman & Co. The present volume is, we believe, but the first instalment of the work, and contains articles by the Rev. John Constable, Principal of Cirencester College; Professor Church, Mr. Warrington, and others. Mr. Constable's essay is upon the question of agricultural education, and in it, while he suggests the study of the dead languages to those whose aim it is to become polished scholars, he condemns it as a means of "leading out" the mind of those who belong to the middle classes. He objects very strongly to the system of theoretical teaching adopted nowadays in most of our agricultural schools, and though he disapproves of the practical learning which results from apprenticeship to farmers, he thinks that in a properly organized institution sound theory and practice may be taught together. It may take a long time, says Mr. Constable, to remove prejudices; but if agricultural colleges have their lecture system fully illustrated by contiguous, well and profitably-managed farms; if they persistently open their doors to the inspection of practical men; if they invite eminent and successful agriculturists to test the practical knowledge of their pupils, by examining them in the details of farm-labour; on the farm—not in the lecture-room—where the animals and crops are before both the pupil and the examiner, then will it be confessed that such colleges can teach both theoretical and practical agriculture. Professor Church's paper is upon certain experiments made upon the growth of wheat, and in it he draws the following conclusions:—1. The seed-wheat of the greatest density produces the densest seed. 2. The seed-wheat of the greatest density yields the largest amount of dressed corn. 3. The seed-wheat of medium density generally gives the largest number of ears, but the ears are poorer than those from the densest wheat. 4. The seed-wheat of medium density generally produces the largest number of fruiting plants; and (5) the seed-wheats which sink in water but float in a solution having a density of 1·247 are of very low value, yielding on an average only 34·4 lb. of dressed corn for every 100 lb. yielded by the densest seed. The foregoing conclusions are based upon several experiments; and associating them with certain statistics stated in his memoir, Mr. Church sums up the results of his observations as follows:—1. An average extra return of about thirteen shillings per acre may be obtained by submitting the seed sown to the particular process of selection described in the present paper. 2. A very high standard of density is not required to secure the extra return; in practice, the exclusion of less than 20 per cent. of the seed-wheat will probably be sufficient to insure this result. 3. The process of selection of seed by density is easy and inexpensive ; in some cases, however, it might advantageously be left to the seedsman. 4. An acclimatized seed-wheat yields a heavier crop than wheat grown under different conditions of climate, soils, &c.

In what parts of plants does Potash reside?—On this subject some curious chemico-agricultural inquiries have recently been reported to the French Academy by M. Isidore Pierre. The object of this *savant's* researches was to discover in what parts of cereal plants, and during what seasons, potash is most abundant. In carrying out his investigations, the greatest care was taken to insure the examination of the corresponding parts of several specimens of corn. The plants were analyzed before flowering, in bloom, and in the fruit-time. From a great number of experiments, the author draws the following conclusions :—1. That in the various parts of the plant (leaves, nodes, and internodes) the proportion of potash to soda increases in a well-marked manner as we pass from the lower to the upper parts. 2. That in parts of the same name and position this proportion tends to diminish as the plant advances toward the period of ripening. Sometimes this diminution is much less marked in the leaves than in the nodes and internodes. It seems that potash salts play a more important part in the life of the plant than soda salts : in fact, it is seen that the former predominate in those parts of the plant which may be considered the most perfect in the last-developed portions, whilst soda is generally found most abundant in the structures which are earliest developed, and whose office is rather temporary, or at least of secondary importance. From these facts, it will be seen that the adversaries of the employment of common salt as a manure have a new argument in their favour, so far as relates to the cultivation of corn. The nodes of cereals contain an enormous quantity of potash, more than 4·5 per cent. of their entire weight, and nearly half (42·5) of their ashes.

ASTRONOMY.

Cometary Systems.—M. Hoek, of Utrecht, has discussed the cases among the 65 comets which have appeared since 1844, where the aphelion positions do not surpass an angular distance of ten degrees. Among the ten instances which he has detected where two or more comets come within those limits, he draws especial attention to the case of the comet III. of 1860, and those of I. and VI. of 1863, which were at an angular distance of only three degrees. This proves, he considers, that some comets have on different occasions been near each other at a great distance from the sun. He proceeds to calculate the dates when those three comets were at nearly the same distance from the sun, which he finds to be in the years A.D. 757 and 1021, when they were within 600 and 500 times the length of the radius of the terrestrial orbit, which he thinks proves that they had not been brought together by chance, but that they once composed separate systems in space. From those data he comes to the conclusion that systems of comets exist which have been broken up by the attraction of the sun, and which have thus, in the course of years, become isolated members of the solar system. He is further confirmed in this view by the fact that the orbits of the above three comets intersect each other at the same points of the heavens, which should also take place, as, when the original mass first comes under the influence of the sun, it has a rectilinear motion directed to a certain point in the sky, and the plane of the new orbit must pass through this point. M. Hoek is of opinion that those comets might formerly have revolved round some other star, and recommends careful spectrum analysis of all the comets which appear.

Bearings of Transit Pivots.—Lieut.-Col. Strange recommends, instead of the ordinary Y bearings (as the form of a semicircular bearing is quite unattainable) that of the segment of a circle, or a semicircular bearing in which a broad groove is cut away in the lowest part, so that the pivot rests upon *two* segments of a circle. This he considers far preferable to the ordinary angular bearings; it has been adopted by Continental and British makers. The latter is difficult to make properly, and cuts a groove in the pivots, which prevents the determination of the level error, whilst the wear and tear is excessive, and alters their circular form.

Eye-piece for diminishing the Apertures of Telescopes.—Mr. Dawes describes an instrument for this purpose, by which it can be done without disturbing the telescope, in order to apply a diaphragm of the required dimensions to the object-glass. It consists of an eye-piece, furnished with a revolving diaphragm, containing the apertures of different sizes, each of which can be brought into the centre of the field of view. By sliding one of those apertures towards or from the object-glass, the cone of rays is respectively reduced or augmented, which has the same effect as diminishing or increasing the aperture of the object-glass. A scale affixed shows the amount of the diminution of the aperture. Mr. Dawes has also applied sliding-wedges of neutral tint glass to his solar eye-piece; and one of the great advantages of this method is, that in the case of double stars the larger may be excluded from the field of view (the small aperture of the field of the solar eye-piece enabling this to be done), when the brightness of the faint one may be determined. Thus the companion of *Alpha Lyræ*, when seen beside the large star, is only of the 11·2 magnitude, but excluding it, rises to the 9·7 magnitude. The comparative brightness of the different parts of the moon, and of the surface of the sun with our illuminated atmosphere, may thus be determined. The values of the scales attached to those wedges have been accurately determined by means of stars whose magnitude had been previously found by means of the diminution of the aperture of the object-glass.

Appearance of Mars.—During the last opposition of Mars, Mr. Dawes perseveringly pursued his researches on the surface of that planet, directing his attention not only to the well-known spots but to those features which can only be suspected, or are less distinct. He used every precaution to keep the planet in view until those rare flashes of perfect vision occurred, and thus transferred them to the drawing; finally comparing the latter with the original. Both the micrometer and eye-estimations were made use of, and the times noted. Some curious details were brought out, which he had not seen before. The most remarkable was a long narrow streak, running

N.E. and S.W., in the northern hemisphere, which was seen by him in 1852, but not so perfectly as on the present occasion. Another observation would appear to point to a change,—for a bay which was perceived in 1852 as distinctly oval with a regular coast, was in 1862 seen and depicted as distinctly forked; although, at the latter time, Mr. Lockyer's excellent pictures represent it as seen in 1852. Mr. Dawes thinks it possible that the sea may have receded from that part of the coast, and left the tongue of land exposed. On three consecutive evenings a very white spot was noticed, which certainly did not exist two months previously, and which looked exactly like a large mass of snow, and quite as white as the spot near the South Pole in 1862. On looking over his observations of 1852, Mr. Dawes finds that he has noticed this appearance, and comes to the conclusion that it must be permanent, and furthermore thinks that a mass of snow or cloud would be unlikely to take up its position at this part of the planet, which is near the equator. In regard to the atmosphere of the planet, he is of opinion that it has not in general a very cloudy atmosphere, as the permanence and equal distinctness of the spots at all times were surprising; and the few changes which appeared in their lustre were similarly seen in other parts, and could be traced to other causes. Of course, the white spots, whether of snow or masses of cloud, as the case may be, were an exception to this rule, as those may be expected and have been seen to alter from week to week. One little change near the North Pole was, however, remarked, when a rather thick dark line, which was invisible on November 10, was seen on November 14, when other objects in the neighbourhood were well seen; whilst, on November 10, the northern extremity of a small strait near it was invisible, although it should have been seen quite as plainly as on the 12th. Mr. Dawes thinks that the ruddy aspect of the planet does not arise from any peculiarity in its atmosphere, as the ruddy tint is most apparent at the centre of the planet, and least so where the atmosphere is most dense; and yet, at the latter, the colour is white or greenish-white. Mr. De la Rue thinks that an excellent globe of Mars may be constructed from Mr. Dawes' drawings.

Photosphere of the Sun.—Mr. Fletcher was enabled to observe the disc of the sun to great advantage during this summer. Finding no spots of sufficient magnitude to arrest his attention, he turned the telescope on the surface of the sun itself, and with the help of Dawes' solar eye-piece, armed with a power of 410 and an aperture of a quarter of an inch, saw all the features admirably. He found the entire surface, on each day when it was examined, covered with minute white granules, and although the "rice-grain" comparisons of Mr. Stone are very felicitous, yet the shapes were too various to be accurately described by any general term. They have sometimes been kept in view for a space of from ten to fifteen minutes without any change in situation or form being perceptible. None of that peculiar appearance of interlacing could be detected, unless when the air was tremulous. Mr. Fletcher is of opinion that the granules are not "entities" at all, but only some portions of the sun's luminous atmosphere elevated into the outer or non-luminous atmosphere. They were estimated to be about two or three seconds in length, and about a third of that quantity in breadth, but no general form could be distinguished, and there was no tendency to elongated forms. If such were the shapes observed, he concludes that no interlacing could be perceived unless the granules were discs of extreme thinness ; but no such structure could be imagined. Mr. Fletcher thinks that those phenomena were well known to Sir W. Herschel, and that they are fully described by him in the "Philosophical Transactions" of 1801. The drawings which accompany that paper seem to confirm that opinion.

Mr. Brodie has likewise examined the surface and spots of the sun ; but his estimation of the dimensions of the granules scarcely coincides with that of Mr. Fletcher, as he thinks that some of them are about eight or ten seconds in length and some two seconds broad, and that they were lying in various directions. Mixed up with the "rice-grains" were the other forms which are always visible—those irregular rounded shapes of various sizes which produce the mottled appearance generally seen, the appearance of which has been compared by Mr. Brodie to a coarse shingle beach. He considers that those appearances are due to waves of photospheric cloud, which are not of equal elevation through their entire length, the valleys of the strata of the cloud intersecting each other very irregularly. He estimated the depth of the valleys of those cumuli clouds to be about 1,000 miles ; but that is rather doubtful. The valleys, he considered, were darker than the tops of the ridges, and the whole of the mottled surface of the sun bore some resemblance to the forms of the huge undulations of the mountains of the earth, as depicted in a good map, the elevated portions appearing as minute bright points, but much smaller than the ordinary *faculæ* of the sun. The valleys, on the contrary, were noticed as sometimes speckled with black pores. The phenomena generally seen when a large spot makes its appearance have frequently been observed by Mr. Brodie ; viz., the shelving sides of the penumbra radiated with luminous streaks, which are frequently carried across the umbra, which is occasionally of a wispy form, like the cirro-stratus cloud of the earth ; and when this is the case, the perfectly black nucleus is always seen, though he has never been able to detect any bridge of luminous matter crossing the nucleus. On one occasion Mr. Brodie had an opportunity of observing the disruption of the umbra of a spot, which took place in the course of from three and a half to four hours. A tongue of luminous matter passed from one side of the spot to the other at the rate of 1,400 miles per hour, and he forms the natural conclusion that it is to this mobility that the jagged edge of the penumbra is due, which has given rise to Mr. Nasmyth's "*willow leaves*," and their similarity at those parts to rough thatching. The umbra has occasionally been seen by him as containing isolated rounded portions of luminous matter, like icebergs floating on a black sea ; but those soon joined the edges of the penumbra. Mr. Brodie is unable to reconcile the actual appearance of the sun with the interlacing of the "willow leaves," which, he thinks, would produce a comparative evenness of surface which he has not yet observed.

BOTANY.

An Orchis mascula with double Flowers.—In the *Journal of Botany* for September, Mr. David Moore, of the Dublin Botanic Garden, gives a description of an *Orchis mascula* with double flowers. In the specimen which the writer describes, the parts are so large that the nature of the morphological changes which have taken place can be well studied. Their alterations are extremely interesting. On the sides of the labellum are two smaller labella with short spurs, and in the axils of these other flowers spring. These secondary florets have again rudimentary florets in the axils of their changed labella. There is no ovary, nor column, nor nectary distinct, though in some instances in the secondary flower they are present in a very rudimentary condition. The part where the column ought to be in the general flower is a mass of bracts and incipient florets, forming a depressed raceme. The malformed parts in the incipient flowers do not appear to exceed the usual number of pieces in the regular flower of Orchis.

How to preserve the Colour of Flowers in drying.—Though an account of such a process hardly deserves a place in a botanical summary, it will be of interest to our readers to know that it is possible to preserve the natural colour of dried flowers. The following method has been given in a late number of the *Journal of the Society of Arts*:—A vessel, with a moveable cover, is provided, and having removed the cover from it, a piece of metallic gauze of moderate fineness is fixed over it, and the cover replaced. A quantity of sand is then taken sufficient to fill the vessel, and passed through a sieve into an iron pot, where it is heated, with the addition of a small quantity of stearine, carefully stirred, so as to thoroughly mix the ingredients. The quantity of stearine to be added is at the rate of half a pound to one hundred pounds of sand. Care must be taken not to add too much, as it would sink to the bottom and injure the flowers. The vessel, with its cover on, and the gauze beneath it, is then turned upside down, and the bottom being removed, the flowers to be operated upon are carefully placed on the gauze and the sand gently poured in, so as to cover the flowers entirely, the leaves being thus prevented from touching each other. The vessel is then put in a hot place, such, for instance, as the top of a baker's oven, where it is left for forty-eight hours. The flowers thus become dried, and they retain their natural colours. The vessel still remaining bottom upwards, the lid is taken off, and the sand runs away through the gauze, leaving the flowers uninjured.

Raphides as diagnostic characters.—Professor Gulliver continues his elaborate investigations into the characters of these curious crystalline bodies. In his "practical applications," he mentions that if any British dicotyledon be found abounding in raphides, it must be referred to one or other of the three orders *Balsamaceæ*, *Onagraceæ*, and *Galiaceæ*. These orders of plants are considered to be isolated in this manner from all others, and are especially entitled to be considered *raphidiferous*. Professor Gulliver has figured the raphides in the ovule of *Onagraceæ*, and he states that the peculiar characters are present in the seed-leaves and the leaves, and considers that when the diagnostic mark holds good, as between an *Onograd* and a *Hippurid*, there is no other single difference at once so fundamental and universal between the plants in question, as that those of one order are raphis-bearers, while the others are not so.—Vide *Microscopical Journal*, No. XIX.

Fontinalis antipyretica.—At one of the meetings of the Dublin Microscopical Club, held during the present session, Captain Hutton called attention to the cell-contents of the perichætial leaves of the abovenamed plant. He stated that if these leaves are examined in spring, while the fruit they surround is young, nearly all, except those near the base of the leaf, will be seen to contain a grumous mass of a golden-brown colour, which entirely fills it, with the exception of a small empty space at each end, the cell-wall being of a pale green. On investigation, this brown substance gave the following reactions :—

1. Simply heated, it turned bright green.

2. Hydrochloric acid had but little effect upon it cold, but when heated, it dissolved it, and turned it a very pale-green colour.

3. Sulphuric acid turned it first a bright green, then pale yellowish-brown.

4. Iodine turned it bright green. On the addition of sulphuric acid, it became dark reddish-brown, small quantities of gas being given off.

5. Pernitrate of mercury (Millon's test) rapidily dissolved it without changing the colour. When heated, it turned into a pale-yellow transparent mass.

6. Chloriodide of zinc (Schultz's test) turned it pale green.

7. Alcohol turned it green, but did not dissolve it.

8. Ether—the same.

9. Pettenkofer's test. The syrup turned it pale green. On the addition of the sulphuric acid, gas was given off copiously, and the colour became bright green, which turned with heat to a reddish-brown.

With tests 4 and 6, the cell-wall showed the characteristic reaction of cellulose very distinctly. From these investigations Captain Hutton was of opinion that this substance was merely some modification of chlorophyll, and he pointed out that, both in colour and behaviour with re-agents, it seemed to be very similar to, if not quite identical with, the endochrome of the *Diotomaceæ.* Unfortunately the specimens of Captain Hutton, exhibited, had been kept in a tumbler of water for nearly a month, and consequently the peculiar colour of the cell-contents had in a great measure disappeared, and the whole had become more or less green.

Are there Spiral Vessels in Cotton-fibres ?—This question has for some time past excited controversy in Manchester among the local *savans.* It was thought by certain experimenters that when cotton had been soaked in Schweitzer's ammoniacal solution of copper, the spiral vessels became apparent. Mr. Dancer, however, denies the existence of these structures in cotton-fibre, and considers that the spiral apparatus which has been described by Messrs. O'Neil and Heys can be clearly traced to a mechanical action which the solvent exercises on the vegetable cell.

Amœba-like movements of Plant-cells.—Mr. Archer, of the Dublin Natural History Society, has a valuable memoir upon this interesting subject in the last number of the *Quarterly Journal of Microscopical Science.* He does not confine himself to the consideration of *Zoospores,* bodies which might *à priori* be regarded as possessing powers of motion, but directs attention to cells like those of *Mesotœnium mirificum.* Here the contents of a single cell escape without conjugation through an opening effected by the raising up of a valve or lid-like portion of the parent cell. During this act, the emerging contents are often much constricted by reason of the narrowness of the aperture through which they make an exit, and after emergence the mass becomes rounded. Now *Mesotœnium* is a plant which does not generate

Zoospores, and whose developmental stages are regarded as quiescent; yet here the protoplasmic mass, wonderful as it may appear, actually comes forth into freedom through an opening considerably smaller than even the smallest diameter of the former. This paradox is solved by witnessing the phenomenon. A sort of pseudopodal process is protruded through the opening; a portion of the contents is slowly drawn after, thus relieving the mass behind, which contracts upon itself; and the gradual expansion and extension of the portion outside the old membrane draws with it the whole, and its purpose, whatever it may be, is gained. "What immediately becomes of the 'chlorophyll plate' in this process I cannot say, but the whole contents become more granular, in which I suppose the 'plate' likewise takes a part; or possibly it becomes consolidated in the centre, causing the dark central spot in the spore-like body formed by the emerged contents. It at all events affords no obstacle to a process which at first sight, and until it is properly considered, appears almost like a feat of legerdemain."

Potamogeton nitens in the river Tay.—Mr. John Sim, of Perth, has found the longer form of the plant in the latter locality. The lowness of the water has allowed him to have access to it for the first time, and as he could not determine the name of the plant from want of access to books, he sent a specimen to Mr. Babington, who states that it very closely resembles the *P. anceolatus* of Reichenbach. Mr. Sim alleges that the plant grows in deep and very rapid water, in company with *P. perfoliatus* and *P. crispus.*—See *Journal of Botany*, August.

The Staminal Arrangements of the Rosaceæ.—One of the most important and philosophic botanical papers which have appeared during the past quarter is that by Dr. Alexander Dickson, upon the Morphological constitution of the *Andrœcium* of *Mentzelia*, and its analogy with that of certain *Rosaceæ*. In this paper the writer reviews his subject carefully, and having discussed the relations of *Mentzelia* to the Rose family, he proceeds to give a classification of the latter, founded on the arrangement of the stamens. This may be tabulated in the following manner:—

I. *Alchemilla type.*—Single whorl of stamens *alternate* with the sepals. No true corolla.
  (*a*) Stamens single, *e.g.*, *Alchemilla.*
  (*b*) Stamens compound, confluent with petaloid apices, *e.g.*, *Rubus*, *Rosa*, *Geum*, *Fragaria*, *Spiræa*, &c.

II. *Aremonia type.*—Single whorl of stamens *superposed* to the sepals With or without a true corolla.
  (1) With a true corolla.
    (*a*) Stamens simple, *e.g.*, *Aremonia.*
    (*b*) Stamens compound, *e.g.*, *Agrimonia.*
  (2) Corolla absent.
    (*c*) Stamens simple, *e.g.*, *Sanguisorba.*
    (*d*) Stamens compound, confluent, *e.g.*, *Poterium.*

Journal of Botany, July.

Venezuelan Medicinal Plants.—The following uses of certain Venezuelan plants are given by Mr. A. Ernst:—Coco (*Cocos nucifera*) is cultivated in cocoa estates on the sea-shore, and very abundantly about the Lake of

Valentia. The oil extracted from the fruit is used principally for burning, but it has the disagreeable property of becoming congealed very easily, even in the torrid zone. The hard shell is calcined, and used as a remedy in various diseases. The milk or water of the nut is cooling and pleasant, and is generally taken with gin. Drunk in excess, it is said to act as an aphrodisiac. *Cuji* (*Acacia Farnesiana*) is a plant whose pods in decoction are taken in chronic diarrhœas. The juice of the pounded pods is said to act with good effect in inflammation of the eyes. It dyes the hair black. By condensing it over the fire, it becomes a blackish, exceedingly astringent substance, resembling catechu. The gum which exudes from the stem is used like gum-Arabic. *Cardo Santo* (*Argemone Mexicana*) is throughout tropical America one of the most esteemed medicinal plants, and it is almost everywhere known by the same popular name, *Cardo Santo*, or holy thistle. A decoction of the leaves is much used in intermittent fevers, on account of its powerful sudorific properties. Mr. Ernst is acquainted with a man who, after suffering for a whole year, completely cured himself in a short time by using this remedy. A decoction of the seeds has the same effect.

Aspidium fragrans.—In a note to the *Canadian Naturalist*, vol. ii., No. 3, we find that Dr. Thomas has been fortunate enough to discover this rare fern at Rivière-du-loup (en bas). The only other locality known to the discoverer is the east shore of Lake Superior, in rocky open woods, where it was found by Mr. Barnston in 1859. *Asplenium viride* has also been found by Dr. Thomas at the same place. The provincial range of this fern would thus appear to be from Canada East and New Brunswick to Newfoundland.

CHEMISTRY.

The Preservation of Wines has received considerable attention from M. Pasteur, who now advances his opinions as to the requisite conditions for the preservation of the fermented products of the grape. He believes that he has established—(1) that wine ripens, or, in other words, is improved by age simply by the action of atmospheric oxygen; (2) that when wine becomes what is called sick, it is in consequence of the presence of parasitic vegetation; (3) deposits form in wine, either in consequence of oxidation, or from the presence of parasites, or more frequently from both causes together; (4) the deposits resulting from oxidation adhere, but parasites render wine turbid. Consequently the most important thing for the preservation of wines is to destroy the vitality of the parasitic germs. The author shows that new wine placed in bottles from which the air is excluded gives no deposit, does not change colour, and never develops a bouquet. On the contrary, the same wine under the influence of the oxygen of the air becomes muddy, loses the taste of new wine, does change in colour, and acquires a bouquet: he adds, that *all these effects of "ageing" may be produced in a few weeks.* His process consists essentially in destroying the vitality of the parasitic germs by exposing the wine for a time to a high temperature. It is, he says, sufficient to raise the wine for a few minutes to 60 or 70 centigrade (140 to 150° of our thermometer), to give an extraordinary power of resisting sickness. After heating, it is said that the wine may be exposed to the air without fear of its becoming acid. As regards the flavour of wine treated by the author's process, he states that a professional taster, who had made comparative experiments without knowing which had been submitted to treatment and which had not, gave a preference to the *treated* wines in nine cases out of ten.—Vide *Comptes Rendus*, Aug. 14th.

The Death of Signor Piria was announced to the French Academy at one of its meetings in August, by M. Dumas. Signor Piria was well known to chemists through his researches on *Salicine.*

The Action of Mycoderma Aceti in Fermentation.—In a late number of the *Annales d'Ecole Normale,* M. Pasteur has written a valuable paper on the phenomena which take place during the formation of acetic acid. The fermentation in which this compound is produced arises, says the writer, from the exclusive influence of a living organism (*Mycoderma aceti*), a very simple vegetable, which consists essentially of frames of little joints slightly compressed towards the middle, and measuring the $\frac{1}{5000}$ of a millimetre in width, and about twice as much in length. However much it may be charged with albumenoid matter, no alcoholic liquid has ever been known to produce acetic acid without the presence of this mycoderm. On the contrary, if a trace of this organism be placed on the surface of an albumenoid liquid alcoholic or slightly acid, it is immediately seen to develop like a filmy veil over the surface ; and, by a correlative action, the oxygen of the air in contact with the liquid disappears, and the alcohol acetifies. It is not necessary for the liquid to contain albumenoid matters ; if the fungus finds, besides the alcohol, a small quantity of alkaline and earthy phosphates, it will live, and its action be the same as before—a circumstance which proves that the albumenoid matter is not the ferment, but the food of the fermenting mycoderm. When alcohol is present, it is, as described above, converted into acetic acid ; but the power of the ferment does not stop here : if there be no more alcohol, it will operate on the acetic acid, and convert it into water and carbonic acid. Such is the action of the mycoderm under ordinary circumstances ; but it sometimes alters, and, having no longer the same consistence or appearance, its effects are different. It is then capable of producing the combustion of the alcohol to the acetic stage, and gives intermediary products with a suffocating odour, and which have already been obtained by the oxidation of ether and alcohol by platinum black.

Nitro-glycerine and its Phenomena.—Nitro-glycerine, a compound which was discovered in 1847 by M. Sobrero, a pupil of M. Pelouze, has recently been very carefully examined, and its explosive properties demonstrated, by M. Nabel. It is formed by acting on glycerine, the sweet principle of oils, with nitric acid, and consists of one part glycerine and three nitric acid ; it is an oily liquid, heavier than water, and is soluble in alcohol and ether. Its properties are very remarkable. It produces such a powerful effect on the nervous system, that a drop of it placed on the tongue causes a headache of great violence, which lasts several hours. It is highly explosive, and ten times more powerful than gunpowder. M. Nabel, who is a Swedish engineer, availing himself of this latter property, has used it with great effect in mining, and with a diminution of expense to the amount of 50 per cent. It requires a smaller chamber than gunpowder, and a mere fissure will do, if lined with clay to prevent the fluid from escaping. The nitro-glycerine is first poured in; then water, which floats on its surface; and there is no necessity for tamping. Ignition is effected by means of a slow match, having a percussion cap at one end. The explosive effect of this compound has been proved by experiments to be very great. In one instance a perpendicular hole, 1¼ in. in diameter, was bored 14 feet from the outer side of a dolomitic rock, and was tamped at the depth of seven feet, as its lower extremity was found to communicate with a cavity filled with clay. A pint and three-quarters of nitro-glycerine was poured in, and filled up five feet of the hole. The result of the explosion was the production of two fissures, one 50 and the other 20 feet long—an immense mass of rock being separated from the main body. In another experiment, a hole was made of the same diameter and depth, at 10 feet distance from the face of the rock. The charge was a pint and a half, and filled about two feet of the hole, which happened to be enlarged, from natural causes, in one place. Sand was placed above the nitro-glycerine. The rock was rent, and a large portion of it shattered; the whole amount thrown down being about 3,500 cubic feet. The gases produced by gunpowder would have been lost in the cavities.

The Preparation of Oxygen from Binoxide of Manganese.—M. Carlevaris, to obtain its oxygen from the peroxide of manganese, mixes it with siliceous sand, and exposes the mixture to a suitable temperature:

$$M_nO_2+S_iO_2=S_iO_2,\ M_nO+O.$$

The evolution of oxygen commences as soon as the temperature of redness is reached; and with a material containing about 90 per cent. peroxide, about 4,000 cubic feet of oxygen per ton will be obtained. Hence, taking into account the cost of the material, the fuel, and the manipulation, the price of the gas will still be very moderate.

How to detect Nitro-benzol in Oil of Bitter Almonds.—A method for the detection of the above-named impurity, based upon a knowledge of the relative actions of sodium, alcohol, and nitro-benzol, has been suggested by Herr Dragendorff. A clean piece of sodium placed in pure oil of bitter almonds causes a slight evolution of gas, and the metal becomes covered with a white flocculent coating. If alcohol is present, the evolution of gas is greater, and the white coating falls away from the metal. Pure nitro-benzol similarly treated with sodium gives off a little gas, darkens but very slightly, and no white flocculi separate. But if a very small amount of alcohol is present with the nitro-benzol, an active evolution of gas takes place, and the liquid very quickly becomes of a dark brown or even black colour. Ten per cent. of alcohol can easily be recognized in this way. To detect nitro-benzol in bitter almond oil, Dragendorff adds four or five drops of alcohol to ten or fifteen drops of the suspected oil, and places a piece of clean sodium in the mixture. If nitro-benzol is present, the metal becomes covered with a yellow or brown coating, the colour being darker as the proportion of nitro-benzol is greater.—*Zeitscht. für Analyt. Chem.*, No. 4.

Relative Composition of Green and Dried Tobacco Leaves.—Much as has been written upon the subject of tobacco and its composition, there is still considerable doubt as to the relative chemical composition of the fresh and prepared leaves. Hitherto it has been believed that the essential principle

—nicotine—is developed in tobacco during the fermenting process to which the leaves are subjected ; but it would appear from some recent researches that the narcotic and stimulant ingredients exist in the green plant. Mr. Ferdinand F. Mayer, of New York, who has completed a number of experiments on this subject, has arrived at the following conclusions :—1st, That nicotina is the active principle in all parts of the tobacco-plant, both before and after "curing" ; 2nd, that there is in all probability no increase, but rather a loss, of nicotina during the drying and "curing," partly or wholly caused by volatilization ; and 3rd, that the plant and its parts contain no trimethyline nor ammonia while in the fresh state.

Constitution of the Niobium Compounds.—At a late meeting of the French Academy of Sciences, MM. Saint-Clare Deville and L. Troost gave the result of their critical researches on the constitution of the compounds of niobium. The authors believing with M. Marignac, that Rose's hypochloride of niobium and the hypofluoniobates contain oxygen, have experimentally investigated this point, and draw the following conclusions from their analyses : 1. Rose's hypochloride of niobium should be considered as an oxychloride. 2. All the extraordinary properties of niobium come under a common law. The oxychloride of niobium is a body which crystallizes in large uncoloured silky tufts. Its vapour-density, from the mean of two experiments, the authors found to be 7·88.

An economic Method of employing the Magnesium Light has been devised by Signor Carlevaris, of Mondovi. He stated, in a recent memoir, that when magnesium wire was ignited in atmospheric air, or pure oxygen, the most luminous effects were not manifest till a certain quantity of oxide had been formed, and was raised by the heat produced to an exceedingly high temperature. The light in this case, as in the combustion of carburetted hydrogen, as in that of hydrogen in contact with platinum, and as in the Drummond arrangement, is derived from the solid particles raised by the flame to a great heat—a heat which dissolves and volatilizes platinum, but leaves the oxide of magnesium solid, fixed, and intact. To raise this oxide to the temperature necessary to give the greatest light, it should be presented to the flame in as small a quantity and as large a volume as possible, which is done by employing a spongy oxide obtained as follows :—A piece of chloride of magnesium is exposed to the flame of the oxyhydrogen blowpipe, in contact with a piece of carbon. The chloride of magnesium is rapidly decomposed, leaving the spongy oxide, which gives the light in question.

A new Modification of Gun-cotton has been prepared by M. Blondeau, and described by him in an important paper presented to the French Academy. This new kind of pyroxylene is said to possess a much higher explosive power than the ordinary kind, and, in addition to this, is unalterable, not only at the ordinary temperature, but does not decompose at 212°. To bestow these virtues upon gun-cotton, it is only necessary to take a good specimen of the usual sort, and expose it for about four hours to the action of ammoniacal vapours. The gun-cotton becomes yellow, and a compound has been formed with the ammonia, having no less a formula than $C_{24}, H_{20}, O_{20}, 4(NO_5)\ (NO_4)\ (NH_2)$. This body, when dried, forms a powder, having the valuable properties we have enumerated.—Vide *Comptes Rendus*, August.

The Oxidation of fatty Vegetable Oils is treated of very fully in a memoir of M. Cloëz, in which he treats of the influence of light and heat on the oxidation. The author's results are of much interest. He exposed oils to the air in colourless glass vessels, and also in vessels of red, yellow, green, and blue glass, and also left some oil exposed to air in total darkness. After ten days' exposure, the increase of weight was greatest in the colourless glass vessel; it was rather less in the blue glass; was very small in the red, yellow, and green; and no increase of weight at all was observed in the oil exposed in the dark. Like results were found after twenty days; but after thirty days' exposure the results were somewhat different. The increase of weight was greater in the coloured glasses than in the uncoloured, green showing the largest increase after 150 days' exposure. It is worthy of notice that poppy oil, after a time, oxidized faster in the dark than when exposed to coloured or white light. Oil heated in atmospheric air oxidized much more rapidly than cold oil. The oxidation may be accelerated without heat by adding some oil already oxidized.—Vide *Comptes Rendus*, August 21.

New Reactions of Gelatine.—Mr. Carey Lea, of Philadelphia, the well-known correspondent of the *British Journal of Photography*, having for years devoted himself to the study of the reactions of gelatine, now announces the discovery of a colour reaction, which is quite novel. Hitherto faintly coloured compounds of gelatine, with a colourless reagent, have been obtained, but in the instance described by Mr. Lea the change from a colourless to a highly-coloured solution is well marked. When a piece of gelatine is dropped into an acid solution of pernitrate of mercury, it gradually assumes a strong red colouration, and after a time dissolves in it completely, at ordinary temperatures, to a fine red solution. This solution deepens a little if boiled for some minutes. By chlorate of potash the hot solution is quickly decolourized, and passes to a pale dirty yellow. This red colouration seems to require a certain amount of time for its production, which cannot be replaced by heat. If a piece of gelatine be immersed in the solution of protonitrate, and boiled for some minutes, it is dissolved, but the solution thus obtained is not red, but yellowish. It is to be regretted that the reaction here described is not more delicate. It is only striking when tolerably strong solutions of gelatine are employed. When the solution is very weak, as, for example, if the gelatine constitutes only one half of one per cent. of the mixed liquids, the limit of the delicacy of the test is reached. Such a solution by standing twenty-four hours exhibits a light but distinct pink colour. Although this delicacy is not what may be desired, still colloid organic substances are so comparatively difficult of qualitative detection as a general thing, that the method is not without value. The experiment was next extended to meta-gelatine. A neutral meta-gelatine was prepared in the following manner:—Gelatine was set to swell in cold saturated solution of oxalic acid, and then a moderate heat was applied for a sufficiently long time for the mass to remain quite fluid when cold. It was then agitated with precipitate carbonate of lime until the whole of the oxalic acid was got rid of. Meta-gelatine prepared in this way was kept for months in a corked phial, in a warm room, without showing any disposition to putrefy.

It was almost as fluid as water, perfectly neutral, and almost insipid to the taste. With this meta-gelatine, the red colouration was produced even more decidedly with ordinary gelatine. The addition of the acid solution of pernitrate of mercury produced at first a whitish flocculent precipitate, which, by standing, acquired a strong red colour, as did the supernatant liquid.

GEOLOGY AND PALÆONTOLOGY.

The Maltese Fossil Elephant.—The curious pigmy pachyderm whose remains were some time ago discovered in the Maltese bone-caves, has been indefatigably investigated by its original discoverer, Dr. Leith Adams. This gentleman has recently met with further relics of the fossil elephant in several new localities. He met with its teeth in great quantities in a cavern near Crendi. In a gap, evidently at one time the bed of a torrent, he has discovered the teeth and bones of thirty more individuals. The skeletons are met with jammed between large blocks of stone in a way which shows clearly that the carcases must have been hurled into their present situations by violent floods or freshes. Dr. Adams has now almost completed the skeleton of this wonderful little representative of an order which, till this discovery was recorded, had been commonly termed gigantic. Dr. Adams concludes, from his numerous inquiries, that the Maltese elephant did not exceed the height of a small pony.

The Geological Magazine has undergone a change of editorship, which may possibly result in the improvement of this periodical. The former editor, Professor Rupert Jones, is no longer connected with it, his place being taken by his colleague, Mr. Woodward. Two new editors have also been connected with the journal, whose names alone afford a guarantee of good science—they are Professor Morris, of University College, and Mr. Robert Etheridge, of the Jermyn-street "School of Mines."

The Origin of Coal.—A new theory concerning the origin of coal and of petroleum has been put forward in America. Our readers are aware that one of the more generally accepted theories of the origin of petroleum supposes that substance to be a product of the distillation of coal by means of the earth's internal heat. The new hypothesis starts a proposition which is the converse of this : according to it, instead of petroleum being formed from coal, coal was formed from petroleum. It is well known that all organic substances which are not themselves volatile, such as wood and other vegetable matters, yield, when submitted to a heat below dull redness, tarry oils having in all cases the general character of petroleum, and differing only according to the specific differences in the materials from which they may have been obtained. The new theory supposes that the materials from which our coal-beds were formed were converted in the first instance into such "tarry oils," and that these oils, under long-continued action of heat, lost nearly all their oxygen and the chief part of their hydrogen, the residuum gradually becoming solid. The "pitch-lake of Trinidad" is referred to in support of this opinion. It is alleged that the theory of coal having been condensed from a liquid in the same way as the asphalte of the lake, accounts better than any other for its purity, seeing that "all impure or foreign substances which did not decompose would most likely be of greater specific gravity than the oil, and would naturally sink to the bottom." The high state of preservation in which plants frequently occur in our coal-beds, and the fact of trees being found erect in them are easily accounted for upon this theory. Trees grow on the hardened pitch of the Trinidad lake within a short distance of other pitch which is in a state of ebullition, and one can readily conceive of the hardened pitch in any similar case being softened by an eruption of the boiling pitch, and of the trees growing on it being thus engulfed, or of the lake overflowing its banks, and so submerging the subjacent vegetation. The new theory also furnishes an explanation of the exceeding tenuity of some coal-seams, which thin out into mere films over extensive areas of solid rock, and might easily be caused by an oily liquid having overflowed the rock when at the surface, and having in progress of time partly evaporated and partly solidified. The shape and dimensions of many other coal-seams are equally consistent with the idea of the seams in question being the solid residuum of what once were lakes of oil, and, indeed, the great majority of all coal formations are basin-shaped, "with long and sloping sides dipping down to a common and profound centre," a fact which certainly tells with great force in favour of the new hypothesis.

An almost entire Skull of Rhinoceros leptorhinus has recently been found near Ilford, in Essex, and in close proximity to the spot where the skull and tusks of the mammoth secured last autumn for the "National Collection" were discovered. The head is nearly perfect, and is that of a rather aged adult, judging by the worn condition of the teeth, of which the whole series on both sides are preserved *in situ.* The fossil is not only interesting, as being the finest specimen of the species yet discovered in Britain, but also as affording conclusive evidence of its having been contemporaneous with *Elephas primigenius.* This specimen will probably enable palæontologists to determine with certainty the species of rhinoceros to which the limb and trunk bones belong that are found intermixed with those of the mammoth ox, horse, &c., in the Ilford beds, and which are of far more slender proportions than those of *Rhinoceros tichorhinus.*—See *Geological Magazine,* July.

Fossil Wood in Flint.—An interesting specimen of this kind, which is in the Oxford Collection, has lately been described and figured in a paper by Professor Phillips. The nodule of flint, which when broken across disclosed the contained wood, was of an elongated oval form, and had the uneven and knotted surface which frequently indicates aggregation on a sponge. The fractured surface showed partial change of colour by watery action from without, and many variations of tint within, arising from some original differences in the composition of the mass. The colour was, on the whole, somewhat lighter than is common in flints of the "Upper Chalk." Examined with a lens, it showed traces of spicula and other organic bodies ; but it was impossible to trace through the mass a distinct spongy structure. The wood lay in the centre, and the figure of the flint was, in a general sense, conformed to it, and embraced it equally on all sides. There was a certain distinctness of colour in the flint where it lay in contact with the wood. The wood was a fragment worn and rounded in some of the prominent parts, and looked like a small portion of a pine branch which had been exposed to rough treatment, so as to present a wasted surface deprived of the bark. It was entirely siliceous, and exhibited its vegetable structure most perfectly. Traversing the woody fibres were several short tubular masses swollen at the end, and marked more or less plainly with transverse rings. These Professor Phillips supposed to be flint moulds of cavities left by boring shells, probably *Teredinidæ.* It would appear that these animals must have begun their operations in a young state on the wood, when it was reduced to its present form and size; for the moulds which remain in their holes appear to be quite small at the surface, and to expand internally. The writer of the paper becomes absolutely poetical in his speculations upon the remnant of extinct vegetation which he described. He writes :—" Far away from the Cretaceous Sea of Albion, among the mountains previously uplifted in the West, from which had flowed the great river of the Wealden, we see a forest of coniferous trees. Whirled and broken to fragments by the rushing stream which received their decaying stems, the ruins of the forest reach the sea, and some few pieces float far from the shore beyond the area of deposited mud and drifted sand. Attacked by xylophagous mollusks, and sinking to the ocean bed, one at least serves as the nucleus for organic growth and accretion." Professor Phillips does not here refer to ordinary accretion; he conceives of the block as first surrounded by organic matter, and then, when buried in the cretaceous deposit, serving as a centre of attraction for siliceous solutions, such as have more than filled to solidity the tissues of sponges.

The Volcanic District of Chili.—Some short time since, M. Pissis, the great explorer of South American geology, transmitted to M. Elie de Beaumont an elaborate description of the volcanic regions of Chili. He found the volcano of Chillans again in a state of eruption. This is a very rare circumstance in the volcanoes of the Andes, where the eruptions generally succeed each other only at very long intervals. The present eruption, which is much more extensive than the last one, commenced towards the end of last November, at a new point, situated about 200 metres below the summit of the grand cone, the new cone having towards the end of January attained a height of 50 metres. The lava escaping by two apertures near the summit, had already reached the vast glacier surrounding this massive volcano. The grand cone, which was covered with snow during the eruption, had the appearance of being completely bare, yet the snow had not been melted, but was covered with a great quantity of projected substances, which formed a layer over the snow of many decimetres in thickness. The alternation of glaciers with layers of scoriæ are frequently met with in the volcanic cones of the Andes; whereever natural clefts occur, a great number of these layers may be seen successively superposed. The volcano of Antuco, visited last year, had been in eruption on a small scale in 1863. As no solid bodies were being projected at the time of his visit, M. Pissis was enabled to examine the interior of the crater, and, favoured by a strong westerly wind, to observe it without being annoyed by the acid vapours which escape in abundance. The principal column of vapour proceeded from an aperture nearly circular, being recognised as that through which the lava had escaped. Its diameter was only from our to five feet; all this portion was covered with yellow or bright red scoriæ, whereas those which formed the border of the crater were of a deep brown colour, nearly black. This difference of colour is supposed to be due to the influence of the hydrochloric acid, which produced chlorides of iron and aluminium, the red colour of the parts when the temperature had been most elevated being probably due to the decomposition of the chloride of iron and the formation of a peroxide. M. Pissis has also described the character of the strata which flank the mountain, but we have not space for a summary of this part of his correspondence.

The Ancient Rhone Glacier.—At the meeting (held at Geneva, in August) of the Helvetic Society of Natural Sciences, M. Alphonse Favre read a most important paper on this interesting ice-sea. The determination of the altitudes at which erratic blocks are found along the old line of that immense sea of ice, which even in its present diminished size is so striking, and in the results of its working upon the general scenery of the country it once covered is so picturesque, has occupied much of M. Favre's time. He believes that the determination of these altitudes fixes approximately the limiting level of the glaciers in the neighbourhood in which they are found, taking, of course, the highest erratics in each district. On this principle he finds that the slope of the ice between the Col de Ferret and St. Maurice has been exceedingly steep; thence to Villeneuve, at the head of the Lake of Geneva, much less steep; while from Villeneuve down to the point at which the ice-stream burst the bounds set by the Jura, where now the Fort de l'Ecluse keeps a jealous watch, the glacier has presented a vast horizontal surface. Of course, on the Jura itself the descending stream has surged—so to speak—to various heights; but on the left bank, by Meillerie, and the foot of the Dent d'Oche (where, however, the ice seems to have risen in a wave), and down to the Voiron, one uniform superior limit of altitude is given by the erratics, being about 1,000 metres above the present surface of the sea, and therefore some 2,000 feet above the Lake of Geneva as it now stands. Before finally reaching the plain of France, the glacier met with a fresh opposition from the M. Sion, 600 metres in height, and here again the erratics tell of a horizontal surface. Beyond the M. Sion another monticule, the Grolée (533 m.), produced a similar result, and then the ice was lost in the plain.

Solid Petroleum has, according to a statement in a recent Philadelphia paper, been found in West Virginia. Some persons owning ground in the district, found upon it a hard black substance, which was supposed to be coal. However, upon chemical analysis it was found to be solidified petroleum, crystallized upon the outside of the vein, and granulated within. It lay in a stratified form, and the vein was of very considerable thickness. So far as traced, the "lode" was about a mile in length. The discoverers, who were determined to put their acquisition to the test, have found that it yields by distillation a pure oil at the rate of from 160 to 170 gallons per ton. The mine is situated ten miles from Cairo, and is about thirty miles east of Parkersburg.

MECHANICAL SCIENCE.

Wire Ropes.—Mr. G. C. Greenwell, F.G.S., has communicated a valuable practical paper on the use of wire ropes in collieries to the Manchester Geological Society. He concludes that round wire ropes are very superior in economy and durability to the flat ropes first introduced, and still generally employed. The maximum safe working strain is given at 5 cwt. for each pound weight per fathom of the rope, if round, and 4 cwt. if flat. The durability is stated to be from one to two years, not being much affected by the load raised daily. Steel ropes are suggested for great depths, and the balancing of the pulley at the pit head on inverted coach-springs, so as to relieve the rope from sudden strains.

Ordnance and Targets.—The Admiralty having erected a new target, representing a portion of the side of the *Hercules,* experiments were made at Shoeburyness which proved that a thickness of armour casing had been attained which afforded perfect security against even the largest guns recently constructed. The target has a facing of 9-inch armour-plates, and contains altogether 11 inches thickness of iron. Against this, three 12-ton shunt guns were fired, at a distance of only 200 yards, with charges varying from 45lb. to 60lb. of powder. One steel shot, of 300lb. weight, $10\frac{1}{2}$ inches in diameter, fired with 60lb. of powder, at a velocity of 1,450 feet per second, barely broke through the armour, without injuring the backing. Sir William Armstrong has expressed his conviction, in the *Times,* that the 600-pounder gun will be unable to penetrate this target, and that it will, in fact, require a gun carrying 120 lb. of powder and steel shot to pierce this massive shield. Mr. W. C. Unwin has pointed out, in a letter to the *Engineer,* that for similar guns, with shot of similar form, and charges in a constant ratio to the weight of the shot, the velocity is nearly constant. Then, assuming the resistance of the plates to be as the squares of their thicknesses, it follows that when the diameter of the shot increases, as well as the thickness of the armour, the maximum thickness perforated will (by theory) vary as the cube root of the weight of the shot, or, in other words, as the calibre of the gun; and the weight of the shot necessary to penetrate different thicknesses of armour will be as the cubes of those thicknesses. The ratio deduced from the Shoeburyness experiments is somewhat less than this, being as the $\frac{2}{5}$th power and the $\frac{5}{2}$nd power respectively. Practical formulæ deduced from experiments are given, which agree with Sir William Armstrong's conclusion, and prove that a gun which can effectively burn a charge of at least 100lb. of powder will be required to effectually penetrate the side of the *Hercules.*

The Friction-break.—Mr. Charles T. Porter has made some careful experiments, in which the power of a steam-engine was simultaneously measured by the friction-break and the indicator. They show so singular a discrepancy, that he has concluded the friction-break to be a fallacious test of engine-power. No satisfactory explanation of the difference has yet been suggested. The power calculated from the weight on the break is greater than that shown by the indicator.

Pressure and Density of Saturated Steam.—Mr. Thomas R. Edmonds, B.A., has communicated to the *Philosophical Magazine* two interesting papers on the laws of density and pressure in saturated steam, giving new formulæ of great simplicity, and closely agreeing with experiment. The papers are too mathematical to be given in abstract here.

Gun-Cotton Engine.—M. Jules Gros has invented an engine which is moved by the action of compressed air, obtained by the explosion of gun-cotton in a strong receiver.

Screw Propeller.—Some remarkable experiments have been carried out upon a steamer belonging to Messrs. Rennie, with the ordinary Admiralty Mangin screw and with a Griffith's screw, fitted with an addition, the invention of Mr. Riggs. This addition consists of a "*boss screw*," resembling an ordinary many-bladed screw, placed behind the revolving screw, and attached to the stern-post. This supplementary screw propeller is fixed, and has its blades set at precisely the opposite angle to those of the revolving screw. According to the theory of the inventor, the action of this screw is as follows :—At the instant of the water being thrown off by the propeller, it is arrested and caused to deviate by the fixed blades as it impinges on them. Hence the water, instead of assuming the form of a cone, directed upwards, and deflected to the right hand or the left, according to the twist of the screw, is sent straight back in a column parallel with the ship's keel, whereby power is saved, vibration arrested, and the steering improved. It is probable that this theory will require revision, but the experiments given below show that the invention has some real advantages :—

	Speed in knots per hour.	Revolutions of screw per minute.
Admiralty Screw	5·871	227
Griffith's and Rigg's Screw	7·574	184

New Pump.—Mr. Wilson has invented an ingenious form of pump, in which valves are entirely dispensed with. It consists of a cylinder oscillating in a tank of water, on trunnions near its centre. The oscillation is caused by the revolution of the crank simultaneously moving the piston. As the cylinder oscillates, it brings the ports on its side alternately opposite to openings from the supply-tank and into the discharge-chamber.

MEDICAL SCIENCE.

Restoration of Life in Warm-blooded Animals.—A most valuable essay from the pen of one of our ablest practical physiologists (Dr. B. W. Richardson) has appeared on the above subject. The writer proceeds to describe the various recognized methods of restoring animation—artificial respiration, exciting the circulation, and heat—and shows that even when the heart has ceased to supply blood to the pulmonic capillaries, during the period previous to coagulation the blood may be driven or drawn over the pulmonic circuit; may be oxidized in its course; may reach the left side of the heart, may be distributed over the arteries, and that thus distributed it possesses the power of restoring general muscular irritability and the external manifestations of life. In one of his experiments upon a dog, the writer, by introducing blood heated to 90° Fahr. into the coronary arteries (pumping it in by the rhythmic movement of a syringe piston), succeeded in making the heart (which till then was still, cold, and partly rigid) pulsate perfectly for at least twenty minutes.

The Phenomena of Deglutition.—M. Krishaber, who has been experimenting with the auto-laryngoscope, with a view to discover the method by which swallowing is effected, has arrived at several conclusions, the most important of which may be tabulated as follows:—1. In the act of deglutition, the alimentary mass passes through one of the pharyngeal arches over one of the sides of the epiglottis; by this means it reaches the œsophagus at the very moment when, by the contraction of the muscles, the pharynx is contracted. 2. The deglutition of liquids is effected in a somewhat similar manner, these passing very often over the epiglottis, in which they differ from solids. 3. A very small quantity of the liquid passes over the edge of the epiglottis, and thus moistens the mucous membrane of the larynx and the cords of the voice. 4. In gargling the throat, the larynx being then much opened, a larger quantity of liquid escapes into the vocal organ. 5. One may easily bear a piece of food in the air-passages, that is to say, in the larynx near the vocal cords, and *even in the interior of the windpipe*. 6. The sensibility of the windpipe to the touch of foreign bodies is far less than that of the larynx. 7. Hard and cold bodies, such as a "sound," are never tolerated by the respiratory passages, although soft bodies which adhere to the mucous membrane, and have the same temperature as it, may remain in the trachea for several minutes without producing any expulsive efforts. Dr. Krishaber concludes his report by mentioning that the experiments which he conducted require very little trouble, and are unattended with danger.

A new poison of the "Dog-bane" order of plants has been examined and reported on by M. Pélikan, of St. Petersburg. The plant which produces it comes from the Gaboon, and is used by the natives of that locality to poison arrows with. It belongs to the natural order *Apocynaceæ*, and produces its injurious action almost exclusively upon the heart. M. Pélikan's experiments were made upon the common frog, and they have led him to the following conclusions:—1. The poison produces at first an increased action of the heart. 2. After awhile the pulse decreases in frequency, and the heart soon entirely ceases to beat. 3. The cessation of action is not regularly progressive. 4. When the ordinary action of the heart has been completely arrested, the ventricle still exhibits peculiar movements, which appear to be peristaltic. 5. When the ventricle has completely ceased to act, and is strongly contracted and empty, the auricles, though full of blood, continue to contract. 6. Finally. The paralysis of the heart has nothing in common with cadaveric rigidity. When once paralyzed, this organ does not respond to any stimuli, whether mechanical, chemical, or electrical, applied either directly or to the nerves.

Two new Anæsthetics, which bid fair to rival even chloroform, have lately been introduced into practice by an English physician. At the meeting of the British Medical Association, Mr. Nunneley exhibited two substances, the bromide of ethyl and the chloride of olefiant gas, which for some time past he had used as anæsthetics. He stated that he had not lately performed any serious operation, either in private practice or at the Leeds General Infirmary, without the patient being rendered insensible by one or other of these agents, each of which he believed to possess important advantages over chloroform. They were among the many analogous bodies experimented on by him, and favourably mentioned in the essay on Anæsthesia, which he published in the *Transactions* of the Association for 1849. At that time the difficulty and cost of their preparation were too great to allow of their being commonly employed. This difficulty, however, has been overcome; and, should their use become general, they can be made at a cost not exceeding that of chloroform. They both act speedily, pleasantly, and well. The patient might be kept insensible for any length of time, while the most serious and painful operations were being conducted. No disagreeable symptoms had in any case resulted from their use.

What is the Physiological Action of Absinthe?—The effects of absinthe-drinking upon the French population have always been regarded as injurious. Until quite recently, however, the noxious results were attributed to the wormwood, which forms the basis of this *liqueur*. M. Deschamps, in a paper read before the Academy on the 10th, has arrived at a different conclusion; he entirely acquits the wormwood of the charge of injurious action, and states that all the bad effects may be attributed to the alcohol. We very much doubt the accuracy of M. Deschamps' opinion, for we think—the therapeutical action of wormwood being admitted—that absinthe, apart from its alcohol, contains ingredients highly calculated to operate detrimentally upon the animal economy.

The Removal of Neuralgic Pain.—It has lately been stated in some of the French journals that Dr. Caminiti, of Messina, has discovered a remedy for certain forms of neuralgia. A patient of his had long been suffering from trifacial neuralgia; she could not bear to look at luminous objects, her eyes were constantly watering, and she was in constant pain. Blisters, preparations of belladonna, and hydrochlorate of morphine, friction with tincture of aconite, pills of acetate of morphine and camphor, subcarbonate of iron, &c., had been employed with but partial success, or none whatever. At length Dr. Caminiti, attributing the obstinacy of the affection to the variations of temperature so frequent in Sicily, adopted the expedient of covering all the painful parts with a coating of collodion containing a certain proportion of hydrochlorate of morphine. This treatment was perfectly successful; the relief was instantaneous and permanent, and the coating fell off in the course of one or two days.

The Origin of Dwarfism, a subject of the highest interest to the teratologist, has been lately discussed in the Academy by M. Dareste. In his memoir M. Dareste attributes the cause of dwarfism to an accelerated development. His experiments were conducted upon hen-eggs which were undergoing incubation. Of a number of eggs which were being hatched, some underwent their completion more rapidly than others, and these M. Dareste examined. On the 3rd of June, at two o'clock, he opened the shell of an egg which had been placed for incubation at ten o'clock on the morning of the 2nd. The embryo had been some time dead, so that the entire duration of its life could not have extended over more than from twenty-four to twenty-six hours. Nevertheless it had attained a condition of development which under ordinary circumstances must have taken sixty hours to arrive at. The left side of the head was bent upon the vitellus, though the rest of the body had its ventral surface applied to the vitelline mass. This precocious embryo was exceedingly small, and its measurements were far below those of ordinary embryos which have attained a similar degree of development. M. Dareste, employing the expressions of M. Isidore Geoffrey Saint-Hilaire, shows that embryonic phenomena are of two kinds: first, the formation of definite organs from a structureless mass—this is *development;* and, second, the increase of their organs—*growth.* If the latter process be in excess of power, a giant is produced; but if the former, a dwarf is the result.

The use of Iodide of Potassium in Mercurial Palsy has been illustrated in a case which was described in a late number of the *Comptes Rendus.* The symptoms and treatment of the disease were stated in a sealed packet, which was forwarded to the French Academy in 1843, and which was recently opened and read, at the desire of its authors, MM. Melsens and Natalis Guillot. The patient, who had complained for years of pains which had resisted all forms of treatment employed to remove them, was put under the influence of iodide of potassium, given, according to M. Melsens' formula, in the proportion of 4 grammes of the salt to 125 of water. The medicine was each day repeated in the same dose for a period of twelve days, at the end of which time the pains completely disappeared, and the patient was discharged well. The deductions, drawn with some reserve by the *savants,* and which we suppose they have since corroborated, are as follows:—(1.) In the case of tradespeople who work with mercury, this metal is liable to become deposited in the tissues. (2.) Mercury may be removed in the condition of a double salt by the action of iodide of potassium.

The Therapeutical Action of Mineral Waters.—It cannot be denied that mineral waters possess therapeutical powers of some importance. We do not mean when they are taken into the system through the ordinary channel, but simply by their contact with the surface of the body. The fact of the existence of so many watering-places, where baths of mineral water are employed, is of itself alone an argument in support of this opinion. But though the remedial property of mineral waters be established, their *modus operandi* is as yet hardly ascertained, and is at present the subject of a very animated controversy in the French Academy, between M. Scoutetten and certain other *savants.* The later researches of M. Scoutettn have been recorded in the *Comptes Rendus*, and from that periodical we extract the following conclusions, which have been formulated by the writer :—(1.) When platinum electrodes are placed in ordinary water, contained in vessels of glass or porcelain, no trace of dynamic electricity is apparent, and the galvanometer needle does not become deflected. (2.) When the same experiment is tried with mineral waters, the deviation of the needle is considerable. (3.) When the same mineral water is examined at various periods subsequent to the date at which it was drawn from its source, and at different temperatures, it is found that the higher the temperature is, the greater is the electric manifestation, a result which is due to the greater amount of chemical change which takes place during high degrees of temperature. From the conclusions it will be observed that M. Scoutetten believes in the electrical rather than the chemico-physiological action of mineral waters. In some minor experiments which this *savant* conducted, he discovered that even the partial immersion of the body in a mineral bath produces an amounts of electrical excitation which occasionally extends so far as to produce feverish symptoms.

Poisonous effects of Nitrite of Amyl.—At the meeting of the British Association, which has just been held at Birmingham, some discussion took place as to the precise action of this substance. We believe we are correct in stating that no more extensive inquiries than those of Dr. B. W. Richardson have been made into the action of nitrite of amyl. We therefore subjoin the conclusions at which this physiologist has arrived :—

(1.) Nitrite of amyl is absorbed by the bodies of animals however introduced into the organism—by the skin, by the stomach, by the lungs, by the cellular tissue.

(2.) After its absorption, its effects are seen immediately on the heart and circulation : there is in the first instance violent action of the heart with dilatation of the capillaries, followed by diminished but not extinguished power of the heart, and contraction of the extreme vessels. As an excitant of vascular action, the nitrite of amyl may be considered the most powerful agent as yet physiologically discovered.

(3.) On animals, such as frogs, whose bodies admit of its removal spontaneously, and whose circulatory and respiratory systems are simple, the nitrite suspends animation, and when the animals are placed under favourable conditions for the process of recovery, they may recover after considerable periods of time. There is no other known substance that suspends animation in these animals for so long a period. On warm-blooded animals, which are clothed in thick and less penetrable skin, and in whose bodies the circulatory and respiratory systems are more complicated, the nitrite cannot actually stop the movements of respiration and circulation without destroying life. But even in these animals it can, without destroying life, reduce the forces of respiration and circulation so extremely, that a condition precisely analogous to what is known as *trance* or *catalepsy* in the human subject, can be brought on and sustained for many hours.

(4.) The nitrite of amyl is not an anæsthetic. By it consciousness is never destroyed, unless a condition approaching to death be produced.

(5.) The effects of the nitrite on the organism are directed to the motive force, which it first wildly excites and then subdues.

(6.) The *modus operandi* of the nitrite appears to be by arresting the process of oxidation in the tissues.

(7.) Physically the nitrite holds a place between the volatile bodies, such as chloroform, and the solid bodies, such as opium and woorali. Hence its effects are less evanescent than those of the very volatile substances, and less certainly destructive than the solid substances. In this lies the secret of its prolonged action.

Influence of Carbonic Acid on the System.—M. Demarquay, whose experiments on the action of carbonic acid have been made both upon himself and his pupils, draws several conclusions as to the poisonous nature of this gas. Of these the following are a few :—

(1.) Carbonic acid exercises an excitant action upon the surface of the skin, the effect being more marked according as the skin is delicate or extensively supplied with nerves ; the perineal regions being especially the seat of this external action.

(2.) Insensibility of the skin is only produced when a continuous jet of the gas is allowed to play upon a limited portion of the external surface.

(3.) The general influence of the gas extends to the organs of sense, consequently marked excitation of the nervous system is observed.

(4.) It exercises a stimulant action, accompanied by a slight nervo-vascular excitation upon the digestive passages.

(5.) When injected into the veins it is largely absorbed, and rapidly eliminated if the operation is conducted with proper precaution ; or it may act mechanically by producing a considerable distention of the cardiac cavities, and finally death.

(6.) When introduced into the body through the respiratory passages it does not produce those poisonous effects so often attributed to it. In fact, when it is administered at first, in the proportion of one-fifth, or even one-fourth, to four-fifths, or even three-fourths, of air or oxygen, mammals may breathe it for a long while without becoming seriously inconvenienced. In man, in the above proportions, it produces little discomfort.

(7.) Most of the accidents which have been attributed to the action of carbonic acid are really due to the influence of carbonic oxide, sulphuretted hydrogen, alcoholic and other vapours, &c.

(8.) Carbonic acid is not a poison ; it is simply irrespirable, as is nitrogen or hydrogen. It simply prevents (when respired) the foul air of the blood from being exchanged for the vivifying oxygen which arterializes the vital fluid, and allows it to travel through the lungs.

MICROSCOPY.

Abstracts of histological memoirs will be found under the following heads :—

Botany—Raphides as Diagnostic Characters.
Fontinalis Antipyretica.
Are there Spiral Vessels in Cotton Fibre ?
Amœba-like Movements of Plant-cells.
Zoology—The Anatomy of the Pulmonifera.

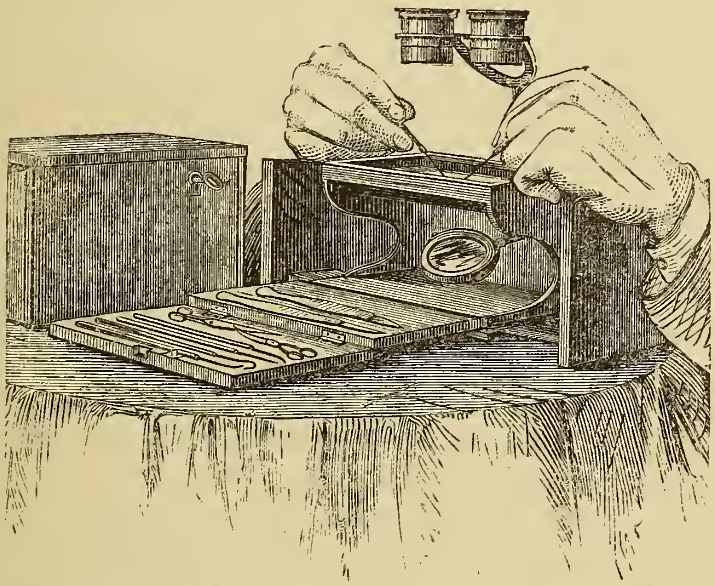
A Wire Spring Clip has been devised by Dr. Maddox. It is employed by him in mounting objects, and will be found of much service to the working microscopist. There is no difficulty in making it; it costs very little, and has the advantage of being easily attached to the slide. The inventor gives the following directions for the preparation of the clip:—Take a straight piece of brass wire, four and three-quarter inches in length, turn one end at six-eighths of an inch with a pair of *wire*-pliers at right angles; this second portion at half-an-inch, again bend at right angles in the same plane; now, at three-quarters of an inch, turn the wire over on itself, having at the bend space sufficient to admit a thick slide. At one inch and five-eighths twist the wire completely on itself, and bring the now short ends at right angles to the longest part; file this end quite flat. Give the first portion of the wire a slight curvature, so that the point and bend may act as a stiff spring against the under surface of the slide when applied. See the *Microscopical Journal*, July.

The Spectro-Microscope.—A most ingenious and useful application of the spectroscope to microscopical inquiries has been made by Mr. Huggins. As his arrangement differs essentially from that of Mr. Sorby, a short description of it will interest our readers. Its greatest advantage is that it can be used with the highest objectives ($\frac{1}{25}$th and $\frac{1}{50}$th inch). Essentially the plan consists in arranging the slit of an ordinary spectrum apparatus in the place of the eye-piece of the microscope. Behind the object-glass, at a distance of three or four inches, an adjustable slit is placed; the object-glass is focussed upon the object on the stage, so that its magnified image falls precisely upon the slit. The opening of the slit, which may be from $\frac{1}{200}$th to $\frac{1}{40}$th of an inch, allows the light of a small part only of this image to pass on to the prisms. If desired, this part of the object may be further reduced by shortening the length of the slit. It is obvious that, by the usual stage adjustments, any portion of the object can be made to fall within the jaws of the slit and to form a separate spectrum. Behind the slit, at its own focal distance, is placed an achromatic lens. The pencils emerge parallel, and then pass through one or more prisms. The pencils are then received by a small achromatic telescope, with which the spectrum is viewed. The eye-piece of this telescope is adjusted, so that the lines of Fraunhofer in solar light, or the sodium line in an artificial light from a source containing sodium, are well defined. The object-glass of the microscope is then to be moved towards or from the object on the stage until the longitudinal lines and bars of different intensity, due to the darker and lighter parts of the object, are sharply defined in the little telescope at the same time as the lines of Fraunhofer or the double line of sodium.

The Quekett Microscopical Club is the name of a new society instituted for the pursuit of histology. It is intended to embrace all those lovers of microscopy who, without a claim to be called professional workers, are yet deeply interested in the science of histology. The first meeting, at which an inaugural address was given by the president, Dr. Lankester, has already been held. There is no entrance-fee, and the subscription is very moderate (ten shillings per annum). We have every reason to think that the new association will prosper, and we do not see why—if it is to be composed solely of amateurs—it should tend to damage the interests of *The* Microscopical Society.

As a rule, however, we are opposed to the "multiplication by fission" process, which unhappily originates many of our scientific societies.

A New Dissecting Microscope has been devised by Dr. Lawson, and manufactured for him by Mr. Charles Collins. It is of the class of *simple* microscopes; but is binocular, the lenses being semi-prismatic convex ones. The powers do not exceed six diameters; but Dr. Lawson considers that in the dissection of the lower animals such powers—when binocular—possess the following advantages over the ordinary dissecting lenses:—1st. That an abundance of room is left between the lens and the object, so as to admit of freedom of action of the operator's hands; 2nd. That the object may be easily and well illuminated by means of the "condenser;" and 3rd. That several structures situate at different levels are brought simultaneously into view.



DR. LAWSON'S BINOCULAR DISSECTING MICROSCOPE.

The stage of Dr. Lawson's instrument consists of an oblong trough of gutta-percha, in which small animals intended for dissection can be pinned under water. In the centre of this trough is inserted a small disk of glass, through which, from a mirror placed below the stage, a flood of light can be thrown upon transparent structures. Two arm-rests draw out on each side of the microscope, on which the wrists can be placed when the observer is at work. The upper and front portions of the case unfold upon the table, and display a series of scalpels, needles, scissors, &c., necessary for the dissection of animal tissues. When closed, the new binocular presents the appearance of an oblong mahogany box, about six inches long by three and a half wide. Its magnifying power is low; but this is more than compensated for by the relief which is given to the object under view, and the large amount of penetration which the glasses possess.

MINING, METALLURGY, AND MINERALOGY.

The Mineral Wealth of Bolivia is, according to the statements of Vice-consul Joel, much vaster than is generally believed. This gentleman alleges that there are almost inexhaustible veins of lead and copper in the neighbourhood of Calama. But the cost of transporting the ore by pack mules to the coast is so great from there being no vegetation and no water for a distance of ninety miles, that until a road for wheeled vehicles be made, the immense mineral wealth of that locality will lie dormant. The same causes militate against the exportation of borax, fields of which, miles in extent, exist near Ascotan, at the foot of the Andes, about one hundred miles east of Calama. The projected railway from Iquique, in Peru, to the interior of the Republic, for which Messrs. Peto & Betts entered into a contract with the Bolivian Government, has been for the time abandoned, in consequence of the late revolution which overthrew the constitutionally-elected President.

Formation of Steel by the introduction of Gases.—At a late meeting of the French Academy of Science, M. Bérard brought before the notice of the *savants* his new method of preparing steel by introducing certain gases into heated metal. This process consists essentially in alternately oxidizing and reducing cast iron in a furnace suited to the purpose. The oxidation is produced in one portion of the cast iron by the introduction of atmospheric air, and the reduction in another by a mixture of hydrogen and carbonic oxide. After twelve or fourteen minutes, the processes are reversed, the portions previously submitted to oxidation being *reduced*, and *vice versâ*. Any oxygen evolved is absorbed by burning coke placed in a proper position. When this alternate action is found by trial to have been conducted long enough, the operation is stopped—decarbonation being the terminating process. During oxidation the bases of the metals proper and of the earths are oxidized ; the sulphur, phosphorus, &c., form acids, and then escape. During reduction the iron is brought to the metallic state, and the earths separate as scoria, any remaining sulphur, phosphorus, &c., being eliminated as acids, and some carbon is restored to the iron. A high temperature is produced during " oxidation," and a low one during "reduction." Ten or twelve tons are manipulated at each operation in the inventor's establishment, and the steel produced is said to have all the properties of the ordinary kind.

Consumption of Wood-fuel in France.—M. Becquerel's memoir affords some very curious information regarding the quantity of fuel consumed at various periods, both for domestic and manufacturing purposes. The writer tells us that under the Consular period, from 1801 to 1804, the consumption of wood was the most considerable ; it fell materially under the Imperial era, rose again under the Restoration, and declined again from 1826 to 1834. The fall continued until 1848 to such an extent as to cause much anxiety to landed proprietors ; but from that period a rise began which has ever since continued. The consumption of charcoal increases in proportion to the population, because the poor find it cheaper than sea-coal. Nevertheless, the consumption of the latter has rapidly increased. In 1821, when pit-coal was not in common use for domestic purposes, the amount of wood consumed was equivalent to 2·5 quintals of pure carbon. This quantity has been constantly diminishing, so that in 1861 it was only represented by an equivalent of 0·687 of a quintal of pure carbon, the difference having evidently been made up by pit-coal. Now, if, says M. Becquerel, the production of the latter were by any chance to decline, it would become necessary to fetch wood from a great distance in order to satisfy the wants of the capital, and its price would consequently experience a rise ; but, were the clearing of forests to continue on the same scale as at present, the price of wood would be exorbitant in a very short time. The great consumption of charcoal induces landed proprietors to cut their wood every fifteen or sixteen years, and even oftener, instead of every eighteen or twenty years, in order to get more wood fit for charcoal, and more bark—the price of which has doubled. Great Britain has only 2 per cent. of forest land ; Spain only 3 per cent. ; France has still 16·7 per cent. ; but if things continue on the present footing, a few years will reduce it to the condition of these countries.

How to prevent the Oxidation of Steel and Iron.—The most novel process for the above purpose is that of M. Chambeyron, by which it is proposed to prevent rust in steel and iron by the forced incorporation of these materials with the volatile metals having little affinity for oxygen. Tinning, zincking, and leading, give only incomplete results, and M. Chambeyron has discovered that it is only by incorporating into the iron itself, and to a certain depth, a metal or alloy little affected by the action of oxygen, and considered practically inoxidisable, that iron and steel can be protected from rust in sea and other waters. The method he employs is to introduce zinc alone in a state of vapour into the iron and steel, when these are intended for exposure to the action of oxygen alone ; and a volatile alloy of zinc, tin, and lead, when the metals are to be exposed to other influences. A high temperature being necessary to vapourise the metals, the operations are conducted in cementing chambers. To each of the cast-iron heads of the upper retorts is adapted a tube, the lower extremity of which dips into the retort, the upper end being terminated by a funnel, which has underneath a spheroidal reservoir, furnished above and below with a tap for shutting off communication either with the retorts or with the interior of the reservoir. The metals to be incorporated are poured in a state of fusion into this funnel, whence they fall into the retort, the high temperature of which converts them very quickly into vapour. In case the pressure produced by the vapour is not strong enough to effect the incorporation, a part of the gas of the gasometer is caused to flow into the retort, and thus increase the pressure. When the metallic vapours have been incorporated in the pores of the iron and steel they are condensed by the diminution of the temperature. We are not aware whether M. Chambeyron's process has been yet properly tested, but its principle certainly promises well.

Metallic Tungsten.— It is stated in the *Mechanics' Magazine* that a Swedish metallurgist has discovered a means of reducing tungsten, by which he obtains it at once in a state of fusion, and that ingots of the pure metal weighing several pounds each are now on exhibition at Stockholm. It is alleged, too, that the cost of obtaining tungsten by the new method does not exceed a few shillings per pound. If really obtainable thus cheaply, a metal which will bear exposure to so intense a heat without undergoing either fusion or oxidation must prove of incalculable value to certain of the arts, provided that the difficulties in the way of working it are not insuperable. With the exception of gold and platinum, tungsten is the heaviest metal yet known. Its specific gravity is about 18, that of gold being 19·36, and that of platinum 21·53.

An improved form of Iron.—An improvement in iron (says a New York paper), increasing greatly its tensile strength, is claimed by Mr. J. D.

Williams, of Pittsburg, U.S. Tested at Fort Pitt, a specimen of wrought iron made by him was subjected to a strain of 166,900 lb. per square inch, without breaking, which is nearly twice the endurance of any iron ever tested, and is much greater than that of cast steel. The process of imparting this unexampled tenacity of strength to iron, adds only two dollars per ton to its cost. If after facts justify this test, it will add nearly 150 per cent. to the strength of steam boilers, the thickness of plate being the same. Chains of equal tractile strength can be made of less than half the iron now used. For suspension bridges it will be invaluable. The improvement is chemical in its nature, and is applied in the boiling furnace. The iron of which the piece which was tested was made, was principally anthracite pig, with a small quantity of charcoal iron.

The Coal Trade.—The quantity of coals, cinders, and culm, shipped and carried coastways from port to port of the United Kingdom rose to 10,970,711 tons in the year 1864, an increase of 382,000 tons over the previous year. 3,116,703 tons of coal were brought coastwise into the port of London, and 2,359,723 tons by inland navigation and land carriage, making in all 5,476,426 tons—an increase of 349,000 tons over the previous year, but the increase was entirely in the quantity arriving by inland navigation and land carriage. 8,809,908 tons of coal, cinders, and culm, of the declared value of £4,165,773 were exported from the United Kingdom to foreign countries and the colonies in the year. This is an increase of 534,000 tons over the previous year.

PHOTOGRAPHY.

Transferring Photographs to Metal for Printing.—Some months since we called attention to some very promising experiments in this direction, conducted by Mr. Woodbury of Manchester. These have resulted in a process recently patented, which is likely to assume a very important position in the arts. Mr. Fox Talbot has the merit of first pointing out the facts upon which it is based. This gentleman, to whom photographers too often forget how much they owe, discovered in connection with one of his photo-engraving processes that gelatine when dissolved in hot water, if mixed with bichromate of potash or ammonia, dried, and exposed to the action of light, would become insoluble. A result due to the decomposition of the alkaline bichromate and the liberation of chromic acid. It will at once, therefore, be seen that a coat of the bichromated gelatine on a glass or metal plate placed under a negative and exposed to light, would, when subjected to the action of hot water, be dissolved away in some parts, and in other parts unaffected, thus producing a photographic positive *in relief*. Acting on these facts, Mr. Woodbury takes the image in relief so produced, and either by mechanical pressure with some soft metal, such as type metal, or by the usual process of electrotyping, produces an *intaglio* impression therefrom. A properly prepared ink, formed with gelatine and some black or other coloured pigment, is then passed over the plate, with which the impression is filled up even to the surface. Of course the gradations of *relief* in the bichromatic gelatine print, form gradations of *depth* in the metal intaglio, in which again the ink, being transparent, forms gradations of blackness proportioned to its varying thicknesses. When this ink is transferred to paper, delivered as a jelly is from its mould, the delicate tints, the deepest shadows, and the intermediate gradations of the photographic negative, are faithfully reproduced. In preparing the relievo, two ounces of gelatine are dissolved in six of water, and to this is added three-quarters of an ounce of lump sugar. Four ounces of a solution containing sixty grains of bichromate of ammonia to the ounce being added to this, the whole is then, while quite warm, strained. A plate of glass is next covered with a sheet of talc temporarily fixed by a few drops of water; the talc is coated with the above, and being sensitive to light, is placed in the dark to set. This done, the coated talc is removed, a negative laid over the talc, and exposed to light in the usual way, the only change being that of causing the light to pass through a glass condenser and fall on it in a parallel direction. The hot water is then applied as above stated. In order to insure perfect flatness while the cast is being taken, the talc side of the film should be again fastened to a plate of glass with Canada balsam. Mr. Woodbury calculates that with three or four presses going, these mechanically printed photographs could be produced at the rate of 120 per hour. Apart from ordinary purposes, the process can be applied to glass for transparencies; to china for burning in with enamel colours; to the production, at a cheaper rate, of porcelain transparencies, &c., &c. At present the prints exhibited are said to lack clearness; and the high relief of the extreme darks are also objected to.

Actinism.—Professor Miller, the American author of a recently published and important work on chemistry, has been engaged in a series of experiments, demonstrating that bodies possessing an equal power of transmitting the luminous rays, vary considerably in their power of conveying the chemical rays; a fact of no small importance to photographers. In the course of these experiments it was found that although water, ice, white fluor-spar, and more especially pure rock salt, possessed considerable diactinic power, neither these nor any other substances equalled in this particular rock-crystal. The different varieties of glass were found to transmit rays extending beyond the range afforded by quartz nearly one-sixth, and a plate of glass less than one-hundredth of an inch thick cut off these rays almost as completely as a plate of twenty times that thickness did. The vapour of water, although very impervious to the calorific rays, freely transmitted the actinic ones; and of all the liquids examined, water was found to be next in order to alcohol in its possession of diactinic power.

The Aniline Process.—It has been suggested as a means of improving this process, by Mr. Carey Lea, the able American correspondent of the *British Journal of Photography*, that naphthylamine should be substituted for aniline. Since then Dr. Emerson J. Reynolds has published some experiments which seem to prove that Mr. Lea is right.

The Caoutchoucotype.—This word—which sounds like a sneeze—is the not very attractive title given by the editor of the *American Journal of Photography*—Mr. C. A. Seeley—to a new process based upon the fact, that the compound of rubber and sulphur may be vulcanized by light as well as by heat. The raw mixture is placed in a thin sheet under the negative for a certain time. The effect of so doing is not rendered visible until after the application of a solvent, such as ether, which penetrates and expands the parts not acted upon by light, producing degrees of relief which will enable casts to be taken, as in Mr. Woodbury's process. A very rapidly stopped action of the solvent again applied produces a stickiness, so that when a black pigment in powder is brushed over the surface, it adheres, removing the relievo effect and completing the picture. It seems to us that this process has little to recommend it beyond its novelty.

Photographic Exhibitions.—The display of photographs at the Dublin International Exhibition was a very admirable and interesting one, comprehensive in its scope and of a very high class. Most of our best photographers and artists were represented. The sunny atmospherical effects which are almost peculiar to Mr. Bedford's productions; the humour, pathos, and beauty of Mr. Reglander's pictures, abounding with evidence of artistic feeling, taste, and conception; the clean, sharp, delicate, yet forcible effects of Mr. Robinson's productions; the pictorial merit of Mr. Mudd's, the charming transcripts of Scottish scenery by Mr. Annan, together with the fine works of Mr. V. Blanchard, Mr. Dixon Piper, Thurston Thompson, Vernon Heath, Rouch, Breese, Sir Joscelyn Coghill, M. Roussett, Johnson & Co., and many others, have won palms from new circles of admirers.

The Exhibition of the North London Photographic Association at the Agricultural Hall, Islington, is also a very admirable one. Strikingly prominent by their originality and artistic character are the rare and beautiful works of Mr. O. G. Reglander, every one of which tells its story with a force and naturalness which has puzzled those who are ignorant of the power of the art-science, in the hands of a true artist. Worthy to rank with these productions is "The Zealot," a picture by Mr. V. Blanchard, the sentiment and feeling of which are admirably expressed with a breadth and picturesqueness of effect seldom equalled. Aiming in the same direction, but with much less power and ability, are the conspicuously hung photographs by Mr. H. P. Robinson, which, although well deserving the high praise we have awarded them in the above paragraph, yet regarded in connection with this clever manipulator's imperfect art-knowledge, and their extravagantly ambitious character, must, we fear, be characterized as very presumptuous efforts. Some life-size photographs by Mr. Aldis are excellent; specimens of Mr. G. W. Simpson's printing process—described in our last—and of Mr. Woodbury's, are eloquent in their advocacy. Mr. Breese's stereographic transparencies are wonderfully beautiful; the portraits by Mr. Leake and those by Mr. Foxlee also deserve warm praise. In connection with this exhibition, complaints have been made public against the way in which the jurors have awarded the medals. Mr. Thomas Ross, the eminent optician, has very properly declined the questionable honour conferred upon him, and sent back his medal, stating that "the only terms on which he could accept a medal" would be that his productions should be subjected to the test of "a *careful and scientific* examination;" whereas although he was present during the so-called examination of the jurors, he was not asked for the key of his case, and that his lenses were not previously inspected by these gentlemen. Other exhibitors point out that the jurors were not competent to decide upon the relative merits of their productions, being ignorant of the principles of their manufacture; others complain that their goods were refused the medal upon the ground of defects existing which their productions did not possess, and that a medal was awarded for other goods in which such defects, or so-called defects, actually did exist. But the most comical of all these things is the reason given by the jurors for withdrawing a medal promised for "the most artistic picture or pictures." Of the five adjudicators, not one is an artist, and with the exception of one, or perhaps two, all are exhibitors, while four of the five are well known to be most intimate personal friends. Amongst these friends and jurors who exhibit is a gentleman who writes critical articles for the *Photographic News* and the *Photographic Journal*—the two editors of which journals are also jurors. On paying a second visit to the exhibition we were pleased to perceive that this gentleman's productions had been judiciously labelled with tickets, stating that they were not intended for competition.

Photography and Decorative Art.—Mr. W. H. Smith, of Haverstock Hill, has patented a new process of photographing on wood for decorative purposes, which may be briefly described. The veneers or panels intended to be photographed upon are coated with gelatine, or other animal or vegetable size, and when a good surface has been obtained, it is next coated with gelatino-chloride of silver, and allowed to dry. They are then put in contact with the negative, and printed in the usual way. They are washed, afterwards toned, and, lastly, fixed with sulphocyanide of ammonium. Wood of any description, prepared in the foregoing way, will keep without discolouring for a long period.

A New Developer.—A very valuable suggestion, emanating from Mr. Carey Lea, has brought forward a new and superior developer, the best formula for which, perhaps, is one given by a clerical correspondent writing to the *British Journal of Photography*, who says :—"Dissolve ten grains of Nelson's gelatine in an ounce of Beaufoy's acetic acid (that at 10d. per lb.). Make your new developer of the strength you are accustomed to use—of course without any acid; and to each ounce of it add one drachm of the gelatinised acetic acid. You will be pleased with the result, and with its cleanliness and ease of preparation." This developer will be found to bring out the images with unusual vigour and brilliancy, and may be retained on the plate for a long time without "fogging." Where from unavoidable difficulties under-exposure has arisen, this quality alone will render it invaluable.

Impure Chemicals.—The *Chemical News*, in a letter from Mr. Ticheborne, asks, in reference to bromide of potassium, if it is a fact that "a small quantity of the iodide makes the bromide crystallize in much larger crystals ?" The writer says, "Although French and German bromine is rarely or ever quite free from iodine, any excess of iodide contained in the bromide is readily removed ; but, practically, traces are not easily separated. After the separation of all but traces of iodine, the salt then forms very sharp and well-defined cubes, far more so than the iodide, the opacity, or transparency, and size of the crystal depending upon the manipulator. In support of this conclusion, I operated upon a quantity of bromine manufactured in Scotland a few months since as an experiment. This bromine did not give the faintest indication of the presence of iodine on the addition of starch acidified with hydrochloric acid and nitrite of potassa, but furnished large cubes of great beauty." This is a matter which will interest photographers. In conclusion, Mr. Ticheborne says, "I am inclined to think the idea that a well-developed cube must contain iodide will be found to be altogether erroneous."

Wavy Lines on the Plate.—To obviate the tendency which some collodions have to form wavy lines when the plate is coated, the editor of the *American Journal of Photography* recommends the addition of chloroform, in the proportion of ten drops to the ounce. He says it is effectual, but we cannot say why it should be so.

PHYSICS.

The nature of the Light Emitted by burning Magnesium has been recently investigated by Professor Schrötter, and his experiments published in a communication to the Vienna Academy of Sciences. M. Schrötter has obtained some important results, of which the most interesting are as follows :—The magnesium light promptly and powerfully produces fluorescent as well as photographic effects. This light contains an extraordinary quantity of ultra-violet rays, the spectrum of which is at least six times as long as that of the luminous portion. Crystallized platino-cyanide of barium, finely powdered or made into a paste with gum, so that it can be fixed on paper, gives a powerful fluorescence when exposed to this light. All substances which become luminous by insulation acquire this property in the highest degree by a few seconds' exposure to the burning magnesium, whilst with the sun it takes from five to ten minutes to produce the same effect. The light re-emitted by these bodies has no photographic power, the absorbed chemical rays being degraded to purely luminous ones. It is further stated that if a piece of burning magnesium wire is brought near to the sides of a white glass cylinder, filled with equal parts of hydrogen and chlorine gases, drops of hydrochloric acid will be seen to condense on the portion of the cylinder nearest the wire. If now a second piece of the wire is burnt on the opposite side of the glass, an explosion takes place almost instantaneously.

Monthly Perturbations of Temperature.—A paper was read before the Academy, on the 28th of August, by M. St. Claire Deville, having the following title—"On the Periodic Perturbations of Temperature in the months of February, May, August, and November." It may be remembered that M. Deville made a series of observations on this subject in May last. He now communicates the results of similar observations made by him during the month of August. He gives a table containing the maximum and minimum of the thermometer, exposed and shaded, the quantity of aqueous vapour, the amount of ozone, and the barometric pressure during the "critical periods" of the month of August. This table shows a considerable increase of the mean temperature upon the 10th and 11th of that month. At the middle of the day, when the temperature was at its highest, the quantity of aqueous vapour decreased, but in the evening abundant rains raised its amount. From the 10th to the 13th the amount of ozone decreased, but augmented on the following days. The atmospheric pressure was high from the 6th to the 10th, but was low on the 11th, the day of the maximum of heat. From the 10th to the 15th inclusive the wind was chiefly south. M. Deville remarks that this year the critical period of August was well marked, at least in the neighbourhood of Boulonnais, where the observations were made.

The Tensile Breaking-strain of Atlantic Telegraph Cables has been fully explained by Mr. Fairbairn, from whose published pamphlet we extract the following table:—

SUMMARY OF RESULTS.

Number of detailed experiment.	Description of Cable.	Breaking-weight.		Diameter of Cable, in inches.	Elongation in 8 feet length of Cable, in inches.	Elongation per unit of length.
		lb.	tons.			
12	Messrs. Silver & Co. ...	130	·058	·35	...	...
13	,, Silver & Co. ...	354	·158	·35	...	...
1	,, Duncan	2,146	·958	·77	17·10	·1781
10	,, Allan	2,258	1·008	...	6·75	·0703 (*a*) ·1380 (*b*)
11	,, Allan	2,818	1·258	·67	1·67	·0169 (*c*)
2	,, Hall & Wells ...	4,946	2·007	·76	2·16	·0225
3	,, Siemens & Co., B.	5,394	2·408	·77	2·60	·0270
4	,, Siemens & Co., A.	5,730	2·553	·77	2·85	·0296
5	,, Glass, Elliott ...	7,690	3·433	1·10	3·77 ?	·0392 ?
6	,, Glass, Elliott ...	7,690	3·433	1·10	4·10	·0427
7	,, W. F. Henley...	9,594	4·283	·85	1·85	·0191 (*d*)
8	,, W. F. Henley...	12,786	5·708	·85	2·72	·0339 (*e*)
9	,, Glass, Elliott, & Chatterton ...	14,783	6·600	1·10	3·57	·0449

(*a*) For outside steel wires.
(*b*) For copper wires.
(*c*) The completed cable.
(*d*) Without outside covering.
(*e*) The completed cable.

Phenomena occurring during the Ebullition of Water. — M. Dufour, of Lausanne, who has so long and successfully examined the phenomena connected with the ebullition of water, has recently added some new facts to this subject. When water boils, the important part played by the air dissolved in it is well known, Mr. Grove having shown that a bubble of steam is never produced without the liberation of an associated bubble of permanent gas, the air or one of its constituents. M. Dufour has now investigated the action of other gases, which are to some extent soluble in water, having tried hydrogen, carbonic acid, and coal gas. The conclusion at which he has arrived is that when water containing either of these three gases in solution is heated to the boiling point, in the presence and under the pressure of an atmosphere of each gas, the phenomena are nearly the same as if the liquid were boiled in air. His experiments show that the great difficulty with which gases leave the liquids which hold them in solution is due to a purely physical adhesion, and not to any chemical affinity between the gas and the liquid ; in other words, it appears that no combination of the gas and the liquid takes place.

How to Make an Intermittent Fountain.—M. l'Abbé Laborde, writing to *Les Mondes*, describes a simple apparatus for producing an intermittent fountain. It consists of an inverted flask fitted with a cork, through which pass two tubes of unequal length. The longer reaches nearly to the bottom of the flask, and outside has a length of some twenty inches. The shorter tube merely pierces the cork, and does not extend to any length inside, and outside it ends immediately in a jet, which can be curved round. The flask is filled with water, fitted with the two tubes, and then, with the finger on the shorter tube, is inverted, plunging the end of the longer tube in a vessel of water. The instrument may now be fixed in this position, as an intermittent jet of water begins to flow at once, continuing until the flask is empty. The column of water in the longer tube will be seen to be alternately rising and falling, from which phenomena an explanation has been given of the cause of the intermittent flow.

A Powerful Thermo-Electric Battery.—At a meeting of the Royal Institution, held some time ago, Mr. Ladd exhibited in the library a powerful thermo-electric battery, made in the manner invented by Marcus, of Vienna. Although the instrument consisted of only ten pairs, and the means of heating it by a row of gas jets had been hastily devised, yet on making and breaking the circuit a spark was readily obtained. The current from this thermo-electric battery was sent round an electro-magnet, and lifted a very considerable weight.

A Novel Method of Telegraphy.—M. Eugène Godard, the imperial aëronaut, has made some very interesting experiments on the subject of a new method of telegraphing. By the aid of a single luminous point M. Godard sends messages to any part of the visible horizon. The experiments were tried at the Observatory and in the Rue de Puteaux. A lamp to which a reflector was fixed was placed in the third floor of a house in that street, while a similar lamp was burning on the terrace of the Observatory. Within three minutes M. Godard sent a message of twenty words to the Observatory. The system is extremely simple. By means of screens, which by concealing or allowing the light to escape, partial or total eclipses are produced. The screens are either of white or red glass. The colours emitted and the duration of that emission suffice to form an alphabet analogous to that of words used by the usual electric telegraphs. The extreme simplicity of this method would be specially useful for signalling at sea in times of war. Two *corps d'armée* could thus most easily communicate with each other.

Lightning Conductors.—At one of the summer meetings of the Brussels Academy of Sciences, M. Melsens read a note "On Lightning Conductors, and on some Experiments on the Induction Spark." Instead of a solid rod, he proposes to use a bundle of wires of small diameter ; the total area of cross section to be at least equal to that of an iron conductor ·020 m. square, or ·02 m. diameter. In the case of the Hôtel de Ville he suggests that the conductor be composed of eight galvanized iron wires ·007 m. in diameter at least. The principal rods are to be led into a well, and are to be connected by numerous branches with the water and gas pipes of the building.

Luminous Radiation at a Red Heat.—An essay on this subject appears in the *Comptes Rendus* for July 3rd. It is written by M. Desains. The author, who experimented with a number of substances, found that the emissive power of oxide of copper was about ten times that of gold; and that the emissive power of platina was between that of the oxide of copper and gold, but nearer to that of the latter. The emissive power of the oxides of zinc and iron is much greater for heat than for light. This is to be expected, from the fact that a number of invisible rays exist; and the thermoscopic power includes all the rays, while the photometric includes only those which are visible. When the emitted rays are joined with rays derived from reflection or diffusion, their polarity is affected.

New Mode of employing Bunsen's Battery.—M. Duchemin, not long since, announced to the Academy of Sciences that in a Bunsen's battery the nitric acid could be replaced by perchloride of iron, and the sulphuric acid by a solution of common salt. He has now stated that by substituting crude chloride of potassium for the common salt, the electro-motive force of this battery is increased, and its caloric effects intensified; the electric light being easily produced when the chloride of potassium is employed, instead of chloride of sodium.

An improved Seismometer or Earthquake Measurer.—Lieut.-Col. Ramstedt, of Helsingfors, has constructed a new form of seismometer, for which he proposes the descriptive name—Telegraph of the accidental movements of the earth. Considering that these movements are much more frequent and continuous than is commonly supposed, and that the greatest number escape notice through want of proper observation, he suggests that his instrument should be placed in the principal magnetic observatories of Europe, and other parts of the world, where, being self-recording, it would note the occurrence of every shock or movement, however slight. If, as Lieut.-Col. Ramstedt remarks, there are tremblings of the earth nearly every day, it seems desirable that some notice of them should be taken; and, perhaps, established observatories would be the best places for the investigation. As all the records would have to be sent to one central office, the localities in which shocks and tremblings are most frequent would be discovered; and, in course of time, some conclusions might be drawn as to whether the movements are periodical, or form part of some intermittent system of vibrations by which the earth is affected. The seismometer is so constructed as to indicate, by lines traced with a pencil, the time at which a shock takes place, and its force and direction.

The Spectrum of the Electric Spark.—The indefatigable Abbé Laborde has made some important observations upon the spectrum of lightning, which are reported in our contemporary, *The Reader.* When the flash appears directly before the spectroscope, as he has been fortunate enough to see it three or four times, the bright lines of which the spectrum is composed are very numerous and well marked. More often the lightning is seen reflected from the clouds in its spectrum, the bright lines are still visible, and increase in number as the flash is more vivid. They are all of a dull white or lead colour, but one among them is always more apparent than the others, and is sometimes seen alone. This line is not far from Fraunhofer's line E. When, however, the flash appears at a great distance, or is seen through a thickness of cloud, almost all the bright lines disappear, and the spectrum is nearly continuous. The appearance is similar to that observed when several unpolished pieces of glass are placed between a source of light and the spectroscope. The Abbé remarks that, when lightning is observed by the spectroscope, it is therefore important to note the degree of visibility of the bright lines it gives, for the thickness and opacity of clouds can vary them greatly.

Wheatstone's new Thermo-electric Battery.—Professor Wheatstone has recently constructed a powerful thermo-electric battery. The battery, the effects of which were shown by Professor Wheatstone to a select circle of friends, is composed of sixty elements. In making it, an interesting and important fact observed by Marcus was confirmed—namely, that the power of the battery is greatly increased by repeatedly re-melting the alloy composing the bars. This is probably due to the gradual breaking down of crystalline structure by fusion. Connecting the terminals of this battery, excited as Marcus's, a brilliant spark was obtained, and about half an inch of fine platinum wire when interposed was raised to incandescence and fused; water was decomposed, and a penny electro-plated with silver in a few seconds, whilst an electro-magnet was made to lift upwards of a hundredweight and a half. Bright sparks were obtained from the primary and secondary terminals of a Ruhmkorff coil connected with the battery. In fact, all the effects obtained from a small voltaic combination were reproduced with ease by this thermo-electric battery, the electro-motive force of which was carefully measured and found nearly equal to two of Daniell's cells.

ZOOLOGY AND COMPARATIVE ANATOMY.

The Muscular Mechanism of the Ostrich's Leg has been very fully given by the Rev. Samuel Haughton, in a memoir in the *Dublin Quarterly Journal of Science* for July. The writer describes minutely the muscles, and their relations and attachments, and then he proceeds to discuss the question of the mechanical value of the several structures. He demonstrates, with all the accuracy of a natural philosopher calculating the power of a system of levers, the exact force which each muscular combination is capable of, and he frames some interesting analogies between the mechanism of an ostrich's leg and that of a Cornish engine. Any observer who examines the gait of the Ostrich, Emu, or Rhea, cannot fail to be struck with the ungainly effect produced in the appearance of the animal when walking slowly, by the abrupt and odd-looking lifting of the foot caused by the structure of the heel joint, giving an effect like that of "string-halt" in horses; but this unpleasing impression would be rapidly converted into admiration if he could see the bird in rapid motion over rough ground, springing from foot to foot, and bending the foot as it left the ground with the rapidity of lightning, avoiding skilfully, without an apparent effort, the dangers of the rough soil. The force expended in propelling the body of the ostrich forward is ten times the force employed in restoring the legs of the animal preparatory to its next spring; more exactly, as 335·5 to 33·75. This enormous force acts upon bony supports, which are required, by the necessities of the bird's existence, to be as delicate and light as possible; and it is, moreover, exerted almost instantaneously, so as to give the fullest effect to the bird's spring. The question naturally arises—how is this force to be suddenly applied without breaking or dislocating the animal's legs? The answer to this question is to be found in the peculiar character of the *rectus femoris* muscle, which binds down the *patellæ*, straps up the heel, and brings the whole machine into harmony at the moment that the spring is about to take place. The admirable mechanical economy of the leg of the ostrich may, says Professor Houghton, be illustrated by the parallel case of the Cornish pumping engine. "Let us suppose a 100-inch cylinder engine about to commence its downward stroke, and to lift the pump-rods, weighing many tons, by means of a force of steam which commences at a maximum, and is gradually let off by expansion to a safe and manageable quantity. It has been found by experiment that it is necessary to cause a minute vibration of the beam before letting on the full force of the steam, such vibration shaking all the nuts and joints into their proper places before the great and sudden action of all the parts takes place. If such a precaution were omitted, the sudden impulse of the steam would break the engine. In the leg of the ostrich, the *rectus femoris* supplies the place of the preliminary vibration; it acts before the extensor muscles come into full play; it binds down the two patellæ, braces up the heel joint, and gives the signal for the *gastrocnemido-solœus*, and other associated muscles, to contract, and thus produces what may be regarded as one of the most striking phenomena in nature."

The Habits of the Blue-Fish.—In the "Proceedings of the (American) Essex Institute" we find the report of a paper, read by Captain N. E. Atwood, upon the change which has taken place in the habits of the blue-fish:— "This fish, which many years ago was very abundant, and held in high estimation by the aborigines of our country, wholly disappeared from our coast in 1764, and not a specimen was seen on the coast, so far as Captain Atwood knew, for fifty years. In 1847 they returned to the north of Cape Cod in great abundance, and have since been taken in large quantities in weirs and nets, and by the hook, near the shore. Now they avoid the shore, and, during the last year or two, have kept in the Bay, where it is difficult to capture them, as they seldom take the hook, though, until recently, they were most voracious and game fish."

The Anatomy of the Pulmonifera has been carefully investigated by Herr Leydig, of Tübingen, whose memoir appeared in *Siebold and Kölliker's Zeitschrift*, and has been abstracted in the last number of the *Microscopical Journal.* The first part of this paper refers principally to the nervous system and organs of the senses, and minute histology of the nerves. Of the ear in these animals, the author observes that his investigations upon Arion, Limax, and Helix, give the following general results:—The capsule in all has the form of a shortly-stalked vesicle. The short stalk is only rendered perceptible by great care in the preparation. The short stalk serves to form a connection with the brain, and does not lead at all to the exterior of the head, so that consequently, when the parts under consideration are not altered through pressure or elsewise, the capsule appears, sharply defined in all its remaining circumference, with a free border. The rest of the paper is devoted to the consideration of the admission of water into the body, and its delivery through the kidneys. The researches of Moquin-Tandon, Lister, Rossmässler, Gegenbaur, Draparnand, and others, on this subject are discussed and referred to.

The Origin of the Vinegar-Eel (*Rhabditis aceti*).—The researches of M. Davaine upon the subject of the vinegar-worm reported to the French Academy on the 8th of August, have given another blow to the spontaneous generation theory. The vinegar-worm, or eel, as it is more frequently styled, is a species of annulose animal, of very low type, found in vinegar which has been prepared from fruit. The circumstance that its habitat is such a peculiarly artificial one has led the advocates of heterogeny to advance this creature as an argument in favour of their views, it being contended by them that, as it only lives in an artificial compound, it must be the result of *spontaneous* generation. M. Davaine's inquiries, the conclusions resulting from which have just been laid before the "Academy," give us many new ideas concerning the habits and origin of the vinegar-eel. His researches show that acidity alone is not a condition under which the worm can exist. The mineral acids, and also the organic ones—oxalic and citric—when diluted to the strength of the vinegar in which the creature lives, destroy its life in the course of a few hours; whilst, on the contrary, a solution of sugar is so favourable to its vitality that it causes it to propagate very rapidly. Although the vinegar-eel dies after about eight days when kept in pure water, it lives for several weeks in this liquid if it contains from one to the two thousandth part of sugar. In water containing five per cent. of sugar it multiplies with great rapidity. There seems to be a relation between the degree of propagation and the per centage of sugar: thus, generation increases notably up to about 30 per cent., it remains stationary at 40 per cent., and ceases altogether—the worms dying—at 50 per cent. The worm multiplies to a greater extent in sugar-water in which the acid is constantly neutralized, than in the acid solution. From these discoveries, M. Davaine was led to place some vinegar-eels in neutral or slightly acid fruits, such as peaches, prunes, apricots, raisins, gooseberries, apples, pears, melons, &c., and in all these they propagated at a prodigious rate. In vegetables, such as peas, beet-root, carrots, &c., they also thrived. Under the various conditions of life to which they were subjected, the worms underwent no modification. These facts indicate very clearly what is the true habitat of the vinegar-eel. It lives and propagates itself by myriads in those fruits which fall upon the ground, and those sweet succulent branches which lie upon the soil. It is endowed with considerable powers of locomotion to enable it to go in search of food; and, as M. Davaine has experimentally proved, it can live for several weeks in moist soil which contains no food whatever. It may therefore be regarded as established that the vinegar-eel, so far from being developed spontaneously during acetic fermentation, is introduced into the liquid vinegar in the grapes, apples, and pears, which are used in its manufacture, and which have lain for some time upon the ground; and that it is perpetuated in the vessels used for the fermenting process, and which are employed for an almost unlimited period for the purpose of preparing vinegar.

A new silkworm is reported to have been cultivated in America. In the *Canadian Naturalist* (Vol. ii. No. 3) we find it stated that, after numerous experiments, Mr. L. Trouvelot, of Medford, Mass., U.S., has succeeded in rearing, successfully, and in great numbers, *Attacus Polyphemus*, Linn., and in preparing from its cocoon an excellent quality of silk, possessing great lustre and strength, and pronounced superior to Japanese and all other silks, except the best Chinese, by competent judges. The silk is unwound by a simple process perfected by Mr. Trouvelot, each cocoon yielding about 1,500 yards. This insect is very hardy, being found throughout the Northern States and Canada; and, as it feeds upon the leaves of oak, maple, willow, and other common forest trees, may be reared easily in any part of the country. Mr. Trouvelot has gradually increased his stock from year to year, by raising young from the eggs of the few individuals first captured, until he has at present seven waggon-loads of cocoons, the entire progeny of which he proposes to raise during the coming season.

A New Actinozoon.—At one of the last sessional meetings of the Dublin Microscopical Club, Dr. E. Perceval Wright exhibited a small actinozoon, which he believed either to belong to the genus Haimeia (Milne-Edwards), or, more likely still, to be undescribed. All the *Alcyonarian Actinozoa* are gregarious—giving rise by budding to variously shaped masses; some of the best known forms being the genera Alcyonium, Virgularia, Pennatula, &c.; but in the first sub-family, Cornulariadæ, the polypes are not as a rule very much aggregated. In the polype now exhibited there was, however, no trace of a cœnosarc, though it had been under observation for some months, and this alone was sufficient to assign it to the division of Cornulariadæ, distinguished by the polypes being "simple, not aggregated, tubular, and retractile." The question then was, did it belong to the only genus thus typified? but unfortunately this genus is described by none save negative qualities, and the species has for its diagnosis "*Polypiéroide brunâtre haut de* 3 *ou* 4 *millimètres*," which is totally insufficient to characterize a species. There can be no doubt as to the individual exhibited being an adult form—the characteristic alcyonarian spicules are found both at the base of the polype and along and at the base of the tentacles: these latter are completly retractile. Should this form not constitute a new species of Haimeia, it is proposed to form it into a new genus called Hartea, after the gentleman who kindly sent it to Dr. Wright, along with other marine creatures, from Rathmullen, County Donegal.

The Anatomy of Nycticebus.—In the elaborate memoir on this subject which has been written by Mr. St. George Mivart, of St. Mary's Hospital and Dr. Murie, the prosector to the Zoological Society, the authors thus sum up the more important structural characters of the animal dissected by them:—If we sum up the results of our investigation upon the anatomy of *Nycticebus tardigradus*, we are led to note the interesting peculiarities offered by the muscles of the limbs,—on the one hand, the reappearance, and, as it were, exaggeration of that anthropoid muscle, the flexor longus pollicis; on the other hand, its resemblance, by the interlacements of its tendons with those of the flexor profundus, to the conditions always offered by the foot in Primates—a resemblance which has already been noticed by Professor Huxley in his Hunterian Lectures for 1864. We are also struck with the almost atrophied gastrocnemius, but concomitantly augmented flexor longus communis, which last, inverting the analogy of the flexor longus pollicis, resembles a hand-flexor in its origin from the proximal bone of the limb. Likewise are we impressed with the very large size of the rectus anticus major, and the generally extensive development of the muscles of the ventral surface of the spine. All these peculiarities of muscular structure must be considered in connection with the singular movements which this animal is capable of making, and which it habitually employs in its arboreal manner of life. We allude especially to its sloth-like mode of progression, and its great power of slowly and easily raising up the head and anterior part of the body, while hanging suspended by its posterior extremities alone.

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